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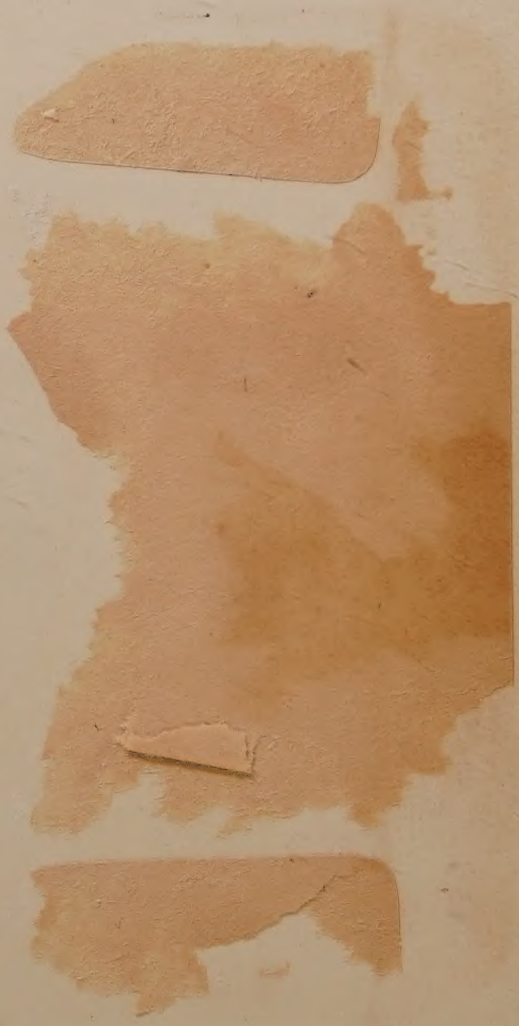

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# MINERAL WATERS

OF THE

# UNITED STATES AND AMERICAN SPAS

BY

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TO

ERNEST ELLSWORTH SMITH, M.D., PH.D.

PRESIDENT OF THE ACADEMY OF SCIENCE, NEW YORK CITY

THIS VOLUME IS INSCRIBED

AS A TRIBUTE TO HIS HIGH PROFESSIONAL ATTAINMENTS

AND IN REMEMBRANCE OF HIS MANY ACTS OF KINDNESS

ENCOURAGEMENT AND HELPFUL ASSISTANCE

TO THE AUTHOR IN THE PREPARATION

OF THIS VOLUME

# PREFACE.

THE object of this work is to awaken the profession to a realization of the importance of our American mineral-water resources, their great therapeutic value in the treatment of chronic disease and to encourage a more thorough understanding of the subject of medical hydrology.

With renewed interest in mineral waters, mineral-water treatment and hydriatics in general, it is thought that a comprehensive and discriminating work on the mineral-water resources of the United States would aid in disseminating a knowledge of hydriatics, which has so long been neglected in this country. The medical student should be well grounded in the physiological action and clinical application of mineral waters in disease; but unfortunately this is not done, and the American medical schools have shown little or no inclination to relieve this dearth of information. It is true that excellent works have been written on the subject by John Bell (1831 and 1855), Moorman (1867), Walton (1873), A. N. Bell (1885) and Crook (1899). These volumes have become antiquated through advancement in the knowledge of hydrology; and the newer and more precise methods in mineral-water analyses.

In this volume are described 425 active spring areas, with analyses of 871 springs; while 424 springs are mentioned which sell water commercially; 240 springs are briefly described which were popular resorts a half-century ago, but have been abandoned or otherwise passed into innocuous desuetude. Other spring areas have been discovered and developed into great spas during the past few decades, more than 100 of which are described and written about for the first time.

The analyses of all springs were recalculated from grains per gallon, the older method of expressing mineral-water analyses, to parts per 1,000,000, the present usage adopted by the State and Federal Geological Surveys; the reason for departing from this time-honored, older, method is given in the introduction.

The author has faithfully endeavored to present the history, location analysis, classification and therapeutic properties of all the active springs in this country, accompanied by a condensed but comprehensive narration of the clinical uses of each spring. The more popular resorts and celebrated spas receive elaborate description, particularly the bathing establishments and their scientific equipment; with a clear depiction of the therapeutic usefulness of the special baths administered, and the clinical uses to which they are adapted.

A feature of the chapter on Classification by Dr. E. E. Smith is the presentation for the first time of a system whereby the medicinal

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qualities of mineral waters are evaluated. Heretofore, no effort has been made to supply this need and hydrologists have been compelled to make use of the purely chemical classification. Under the caption "Medicinal Classification," Dr. Smith has also indicated the evaluation embodied in the tables of analyses presented in Chapter XIV. The author is responsible for the chemical description following, made in accordance with modern usage.

The discovery of radium emanation in mineral waters is of such momentous importance that a chapter on Radio-activity of Mineral Waters has been included.

A chapter outlining the dosage of mineral waters, based on the degree of concentration of the predominating chemical constituents, is incorporated for the first time in a work of this character.

A section on the Greater American Spas has been included and the point emphasized that it is no longer necessary for physicians to recommend foreign spa treatment when we have at home the equal, if not the superior, to any foreign mineral waters, and besides the equipment for scientific spa treatment and its professional supervision is not exceeded at any spa in Europe.

In order to make this work discriminately complete, I realized the necessity of inviting the coöperation of specialists in hydrology to collaborate with me in the production of the work. The contributors who have honored me by writing certain sections were selected because of their erudition in special fields. Their reputations are a guarantee of the quality of their contributions. I take this occasion to thank them for their valuable coöperation in carrying out the work as planned.

It is with grateful appreciation that I extend thanks to Prof. John H. Cowles, for reading chapters in Parts I, II and III, and for his helpful, erudite suggestions regarding the text. Acknowledgment for helpful coöperation from various state geologists is made in the topographical and geological introduction preceding the description of the springs of each state.

The work of collecting the material from which to produce this volume has been arduous, difficult and painstaking. In addition to the author's personal acquaintance with a very large number of the more important spas and their waters, all the available literature on the subject has been carefully scrutinized, including all works on the mineral waters of the United States and bulletins issued by State and Federal Geological Surveys. Letters with questionnaire were sent to every mineral spring and resort owner in the United States; besides correspondence with physicians near spring areas and resident physicians at resorts and spas, postmasters and others.

If this work should be the means of directing attention to, and stimulating renewed interest in mineral-water therapy and hydriatics in general, for the alleviation and eradication of intractable chronic disease, the author's most cherished wish will have been attained.

W. E. F.

New York, 1927.

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# PART I.

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# MINERAL WATERS OF THE UNITED STATES.

## CHAPTER I.

## INTRODUCTION.

INASMUCH as the recorded history of our country goes back to only a comparatively recent date, the written history of our mineral-water resources must of necessity cover only a couple of centuries. When the "pale face" was unknown in this country, so far back into the dim and distant past that the mind of man comprehendeth it not, the Aborigines knew of and resorted to "medicine springs" for relief for their ills and infirmities. Legendary traditions of the curative properties of the more important springs and spas in use today were transmitted to the white men by the Indians.

The history of mineral waters and mineral springs in general, however, dates back beyond the beginning of the Christian Era. The Egyptians, Arabians, Mohammedans, Greeks, Romans and, in fact, all nations have used mineral waters for medicinal purposes from time immemorial. These centuries of experience have demonstrated that in certain chronic ailments the intelligent use of mineral waters surpasses the curative action of Galenicals. While European physicians have always appreciated the curative virtues of mineral waters, Americans have, through apathy or neglect, overlooked the fact that we have in our own country the counterpart of the best European springs.

**Methods of Expressing Mineral-water Analyses.**—In the past mineral analyses have been expressed in grains per gallon, which was popularly supposed to be the most intelligible method to the greatest number of persons; but to adopt this method at the present time would not be in keeping with advanced thought and teaching, for physicians and others of late years have been in the habit of interpreting water analyses only in terms of salts supposedly held in solution in parts per 1,000,000. However, with the acceptance of the ionic theory, the ultrascientific chemist and the professional geologist hold—and possibly they are right in their assumption—that the mineral constituents in solution in a mineral water exists almost entirely as free radicles. The method of expression by radicles enables the analytical chemist to better report the actual relative amounts of each substance found; but to the uninitiated the ionic method of expression is too confusing for general acceptance, for the reason that water analyses have long

been reported in terms of the hypothetical combinations of these radicles and ions. To abandon this custom would lessen the usefulness of the analyses to those familiar only with the hypothetical scheme, and until a wider knowledge of chemistry obtains among physicians and others who are not familiar with the newer method of expressing water analyses, it does not appear that the time is opportune for discarding the scheme of hypothetical combination.

**The Hypothetical Combination Form of Expressing Analyses.**—At the present time analyses expressed in radicles are intelligible only to the analytical chemist, the professional geologist and the professor of chemistry who can picture in their mind's eye the probable combinations of ions present, and formulate the possible therapeutic properties of the water, while the general practitioner understands best the therapeutic action of compounds. For instance, the ion sodium (Na) does not present to his mind the physiological and therapeutic action which the compound sodium sulphate ($Na_2SO_4$) or sodium chloride (NaCl) does. Therefore, we believe that analyses expressed in the hypothetical combinations of ions and radicles will serve better than the ions to show the character of the water, because the combinations enable the physician to see at a glance the relative amounts of the basic and acid ions contained in a given water. Following the practice of the majority of analytical chemists, analyses are computed to and expressed in the hypothetical combinations in parts per 1,000,000 by weight. This seems to be the preferable method in mineral waters, rather than expressing the results in milligrams per liter; because the metric system in this country has not been adopted as the legal system of weights and measures. However, since a liter of water weighs 1,000,000 mg. these two expressions, "milligrams per liter" and "parts per 1,000,000," are practically synonymous. According to the old method of expressing mineral-water analyses, the majority of the springs sent in their analyses expressed in grains per gallon, so it was necessary for uniformity to have all such analyses recalculated to the hypothetical combinations of parts per 1,000,000; likewise, all alkaline carbonates were calculated to the bicarbonates, the form in which they actually exist in the waters.

**Definition.**—The definition of mineral water, in the strict acceptation of the term, is one which, by virtue of its ingredients, held in solution, whether mineral, organic, gaseous or the principle of heat, is especially applicable to the treatment of disease, used either by internal administration or external application. The study of the source and composition of mineral waters is included in the science of hydrology which embraces a knowledge of water, its properties, phenomena and distribution over the earth's surface.

*Hydrotherapy.*—Hydrotherapy is the scientific use of water as a therapeutic agent and its application in the treatment of disease applied in various ways and in various gradations of temperature from ice to steam, as indicated in different diseased conditions.

*Balneotherapy.*—Balneotherapy is that branch of medical science which treats of the constitution of natural mineral waters and their therapeutic employment, especially in the form of baths; the science of baths and bathing, including their effects upon the system, in the treatment of disease.

*Loutrotherapy.*—Loutrotherapy is the knowledge of artificial carbonated baths, and their scientific application, as the Nauheim baths, their preparation and administration, etc., the diseased conditions in which they are indicated, the duration of the bath, and the necessity for a course of graduated baths.

*Crounotherapy.*—Crounotherapy is the scientific employment of mineral waters as therapeutic agents, by internal administration in the treatment of disease. In the employment of mineral waters for "drinking cures" at the spring or spa, we must not overlook the fact that we are prescribing much more elaborate and complex pharmacological preparations than the galenicals we obtain from the apothecary; moreover, their utilization at the spring or spa is usually attended with such favorable conditions as to raise the curative agent to the dignity of a therapeutic method.[1]

*Medical Hydrology.*—Medical hydrology is the comprehensive designation of the whole science which treats of the several factors comprising the medicinal use of water in all its solutions.

*Renewed Interest in Medical Hydrology.*—During the present decade we have witnessed a rather remarkable revival of interest in general physiotherapy. Beyond question, it is a timely and sensible return to the remedial methods so highly extolled by the physicians of the dim and distant past, more particularly by Hippocrates, the accredited "father of medicine," whose work on "Airs, Waters and Places," written on the Island of Cos, 440 B.C., still lives. Mineral waters are more potent and powerful remedies, and more appropriate for the relief of the sick, when scientifically prescribed, than the majority of the profession seems to realize. Of late there seems to have been broadcasted a revival of interest on the part of the medical profession in mineral waters and their therapeutic values, while on the other hand the intelligent laity has always been a firm believer in the curative properties of mineral waters.

It has been the custom of authors of works such as this to preface their introduction with a lengthy historical retrospect, including a summary of all that is known of the early authors and their writings on waters from the days of Moses in Holy Writ down to the present age. I will digress somewhat from this time-honored custom and not tire my readers with a rehash of this historical data.

**The Use of Mineral Waters by the Ancients.**—It is a historical fact that mineral waters have been of great benefit to mankind. For the first five centuries following the Christian Era, mineral waters were the only remedies employed by the Roman physicians, and the "aqua calientes" have been in active use for drinking and bathing purposes

for more than two thousand years. Josephus mentions the thermal baths of Calirrhoe, near the Dead Sea, made famous by Herod the Great, who used them during his illness. The Egyptians, Arabians and Mohammedans record the use of mineral waters for the healing of the sick from the very earliest times. The thermal waters of Bath, England, have a history extending back to the time of Christ, while mythology and legend carry the record back to 800 B.C. The springs of Ala-Shehr, the Philadelphia of the New Testament, have been in use since the Third Century B.C., and the waters of these springs are now bottled and sold throughout Asia Minor, because of their medicinal qualities.

From the earliest records we find accounts of the regard of the ancient Egyptians and Hebrews for the use of waters in bathing as a sacred rite, and the Christian rite of baptism as a symbol of spiritual healing or cleansing, perpetuates the orthodox Jewish rite of bathing. The natives in some eastern countries believed certain rivers to be favored by the gods, and bathing in them was held to be attended by miraculous recoveries. The Nile in Egypt, the Ganges in India, the Jordan in Palestine and the Tiber in Italy were sacred rivers and the bather in these streams was healed or otherwise blessed.

From the earliest time of which we have record mineral waters have been used as remedies for the cure and relief of disease. Among the Romans mineral waters were highly revered as curative agents, not only in Italy, but in all countries over which they obtained dominion. With the modern nations of civilized Europe, mineral waters are held in high regard, so much so, that national regulations have been promulgated from time to time to guard against their improper uses and to insure their scientific application in suitable cases.

**State Supervision of Mineral Springs.**—Some three centuries ago Henry IV of France issued a royal edict prohibiting any person from making use of a mineral water until his case had been diagnosed and the manner of using the waters prescribed. Even today it is the law of France that no mineral water, station or spring can be designated as such until the waters have been examined and approved by the "commission des Eaux minerals" of the Academy of Medicine. (The French Republic owns and exploits most of the valuable mineral springs in France and superintends their use.) In Spain and Portugal the governments exercise control over all sources of mineral waters, supervising their uses and exploitation.

In the United States the Department of Agriculture and of the Interior have undertaken a systematic analysis of the waters of the United States. The Federal Government now owns the valuable spas at Hot Springs, Ark.; the sulphur springs in Platt National Park, Sulphur, Okla.; and the springs in the Yellowstone National Park. The state of Wyoming owns and controls the "Big Horn Hot Springs" at Thermopolis, Wyo. The state of West Virginia now owns and controls the celebrated Berkley Springs in that state. The state of New

York owns the valuable springs and spa at Saratoga Springs, N. Y., and the commission appointed by the governor and the general assembly, with an appropriation of several million dollars, is making strenuous efforts to rehabilitate this spa and to restore it to its former eminence.

The governmental control of these celebrated spas insures the preservation for all time, for the use of the people, the advantages of these natural resources; it gives assurance for the highest degree of protection and the scientific administration of these natural curative agents to the invalid who may go to these mineral springs for treatment. This governmental jurisdiction over a few of the mineral springs of our country is in accord with European methods, and gives promise of becoming an important factor in the suppression of charlatanry in the exploitation of American mineral waters and of establishing American hydriatics upon a dignified and ethical basis.

**European Spas versus American Spas.**—The watering places and spas of Europe taken an annual toll of at least $100,000,000 from American citizens who are seeking health and recuperation at European spas and resorts. Some of them go to foreign watering places under the delusion that foreign things are better than those at home, and that the more inaccessible and expensive a thing or place is, the better it must be, and others go because the prescribing physician is not creditably informed that in our country we possess every kind and class of mineral water which has made the European spas so wealthy and popular. It is a serious reproach on the medical profession that so many thousands, even millions, of patients have spent small fortunes hunting health at European spas when they could have had the same scientific care and more considerate attention at home, and the additional advantage that our American spas and waters are not only equal to any in the world, but that many of them stand in a class to themselves in more than one respect.[2] The Europeans obtain relief at their home spas. Why should not we Americans find health and happiness at our American springs and spas? Changes of scene, climate and travel are just as good and as beneficial here as abroad, and this great country of ours, stretching from the Atlantic to the Pacific, and from Canada to Mexico, has some of the most picturesquely sublime scenery in the world. Why not see America first?

**The Importation of Foreign Water.**—There is imported into the United States annually something like 4,000,000 gallons of foreign waters, representing in cost more than $1,000,000, but our domestic consumption of mineral waters far surpasses this, reaching some 70,000,000 gallons a year and aggregating in value about $75,000,000.[3] The magnitude and great practical importance of this aspect of therapeutics, the use of mineral waters medicinally, ought to awaken in the minds of the profession the great potential possibilities for scientific therapeusis through these natural medicinal agents, which Nature compounds in her laboratory and pours forth from the earth charged with mineral constituents possessing definite therapeutic properties.

**New Facts Revealed by Analytical Chemistry.**—During the past two decades there has been unearthed from various sources many new facts, both by the profession and analytical chemists, which have thrown light on many heretofore unexplainable properties of mineral waters. As the geologist is enabled to construct a prehistoric background through the discovery of causes and methods, by which the structural changes in the earth's surface, through volcanic disturbances or otherwise, affects the mineral constitution of the earth, as regards rocks, mineral deposits, rivers, springs, etc.; so may the physiologist venture to build up at least a provisional working hypothesis on the basis of a few suggestive findings; such an hypothesis led the Curie's to the important discovery of radium emanations.

This physiological research has disclosed the presence of radio-active emanations in most all mineral waters which come from great depths below the earth's surface. This discovery has introduced a new conception of the fundamental problems of existence. The knowledge that there is held in solution in certain mineral waters vast stores of energy, though it be evanescent and elusive, of which, the want of a clear perception, alone, at the present, prevents us from using for the purpose of restoring health and adding to the span of life, raises an issue which it is safe to say will not only mark an epoch in the usefulness of mineral waters, but in the progress of thought in general. Famous health spas and well-known mineral springs have been crowded with patients for generations because of the fame of the curative properties of the waters, which, though unknown and unheralded, were due largely to the radio-active emanations with which the waters were charged.

**Mineral Water Resources of the United States.**—While the enlightened nations of the earth for many centuries have held mineral waters in high esteem as curative agents, yet it is within comparatively recent times that the science of chemistry has revealed their chemical constituents. The quantitative analysis of a water is most important to the physician who is called upon to advise a patient where to go and what waters to drink. Such an analysis will enable the prescribing physician to form a correct general view as to the value and therapeutic action of a water. This information will often prevent the incessant mistakes and possible harmful results due to physicians recommending "hap hazzard" to their patients to drink waters unsuited to the pathology of their ailments.

In no other country, perhaps, do mineral waters abound in greater variety than in the United States, and it can be positively stated that our American waters are just as good, just as potent and just as efficient and found in as great variety as in any country in the world; it is a subject of sincere regret that their physiological and therapeutic properties, applicability and methods of administration have not been given more considerate attention by the profession.

**The Necessity for Clinical Study of American Mineral Waters.**—Although unmistakable evidence of a revival of interest on the part

of the profession in the use of mineral waters is so plainly seen, that even he who runs may read; yet there are many obstacles to overcome: (1) The clinical data relating to the physiological and therapeutic action of the various classes of waters is incomplete and inaccurate and the analyses faulty and in many instances absolutely worthless. (2) The medical profession as a whole understands little of the general principles of balneotherapy and crounotherapy; the American medical schools have shown little or no inclination to relieve this dearth of information. It is true that excellent works have been written on the subject: John Bell's *Baths and Mineral Waters* (1831) and his *Mineral Springs of the United States and Canada* (1855), Walton's *Mineral Springs of the United States* (1873), A. N. Bell's *Climatology and Mineral Springs of the United States* (1885), and Crook's *Mineral Waters of the United States and Their Therapeutic Uses* (1899). These volumes have become antiquated through advancement in the knowledge of hydrology; the newer and more precise methods in mineral-water analyses. (3) Until a decade or so ago, only a few of the better-known spring resorts offered facilities assuring comfortable residence and competent medical departments; but owing to a revival of interest in general hydriatics there are now scores of spring resorts throughout the country offering every comfort for the invalid, while at some of the greater American spas one will find every convenience, comfort and luxury to be had at any spa in the world. (4) Until the past few years only a few of the better class of professional men gave much attention to hydriatics, and, as a result, the class of resort physicians in personality and training were not the type to inspire confidence on the part of the patient or his family physician. It is pleasing to note, however, that the attitude of the profession toward mineral-water treatment has appreciably changed. American physicians are visiting the greater European spas and intensively studying the science of balneotherapy and crounotherapy. The careless apathy and indifference of past years is rapidly changing to active and serious interest, and, as is usually the case, this interest is manifested first by those who stand highest in the profession. The fact that the eminent leaders of the profession, authors of textbooks and moulders of medical thought are already awakened to the importance of the therapeutic possibilities of mineral-water treatment, assures the recognition and the establishment of the scientific application of these naturally endowed remedies from Mother Nature's laboratory.

**The Necessity for Teaching Hydriatics in American Medical Schools.**—We need most of all in this country a chair in each medical school to teach hydriatics. The young graduates in medicine would then be grounded in the subject, and have an understanding of the mineral waters of the United States; know their physiological action and therapeutic properties and have a grasp on their clinical indications. It is of momentous importance that the science of hydrology be disseminated among the profession; for until this is done, American physicians

will continue to send patients to European spas, for they know that at the foreign resorts the patient, upon arrival, will be placed under the care of one who has made a study of the physiological action and understands the therapeutic effects of waters and is skilled in hydriatics. Many of the greater spas in the United States are now expending vast sums of money in the construction and equipment of bathing establishments, many of which excel in many particulars any similar establishments in foreign countries. They have for their medical directors eminent physicians, many of whom have visited and studied at the greater European spas, and mastered the science of balneotherapy and crounotherapy and hydriatics in general; so that it is no longer necessary for American physicians to subject their patients to a long, expensive, tedious and, in many instances, hazardous sea voyages to secure scientific treatment at a foreign mineral spring resort.

Mineral waters are not a "panacea" for all the ills of mankind, but they act like all other medicines by producing certain physiological effects upon the human system and upon principles capable of being clearly defined. There are many diseased states of the system where they are not even indicated, and, if administered, will exert harmful influences. On the other hand, mineral waters are exceedingly valuable medicinal agents, and will unquestionably give relief in many diseased conditions where the ordinary Galenical preparations will not. Nevertheless, it should always be borne in mind that they are not a cure-all, and that to be administered successfully they must, like all other medicines, be ordered after a careful examination of the patient, and with a thorough knowledge of the nature of the pathology of the patient's ailment.

**Clinical Experience Alone Determines the Therapeutic Value of Waters.**— Of late years the Water Laboratory, Bureau of Chemistry, of the Department of Agriculture, Washington, D. C., has taken a rather arbitrary stand relative to the curative value of mineral waters, even going so far as to say that they are not curative agents, and at best only adjuvants to other forms of treatment. Such a pronouncement from laboratory workers is regrettable, and one wonders at the temerity with which, as it were, some people "rush in where angels fear to tread," and make statements concerning remedial agents with which they can have had little or no practical clinical experience. It is upon clinical experience alone that the therapeutic properties of any remedy is weighed, and its curative action determined. Some of the most eminent medical authorities in this and other countries have tested the medicinal virtues of mineral waters and given their unqualified endorsement attesting the therapeutic action of mineral waters as remedial agents.

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# PART I.

# MINERAL WATERS CLASSIFICATION—SOLID AND GASEOUS CONTENT—DOSAGE AND PHYSIOLOGICAL ACTION.

## CHAPTER II.

## GENERAL CONSIDERATIONS.

**Skepticism versus Mineral Waters.**—The pyrrhonistic doubter, like the poor, is always with us, and the medical profession has its full quota, as will be seen from the following question. "Do the waters which issue from the earth charged with chemical ingredients held in solution possess properties which may be made to serve a useful purpose in the healing art? What part do they play and what position do they occupy today in our list of remedial agents?" The medical skeptic of the recent past flourished in large numbers, but their incredulity, based largely on the want of creditable information concerning the physiological action and therapeutic properties of mineral waters, was somewhat justifiable. As a class they are fast dying out, peace be to their ashes. It is beyond question that all of the undisputable cures and recoveries procured from the administration of mineral waters, as reported in medical literature by reputable members of the profession, from the days of Hippocrates down to the present, are the result of fantastic illusions.

**Mineral Spring Advertising.**—The mineral spring advertising circular, clothed in respectable, even ultrafashionable, dress, comes to the physician's desk making extravagant claims, portraying, in exaggerated hyperbole the curative virtues of a certain water, beyond all reason, as a *panacea* for nearly all the ills to which human flesh is heir. When the astute physician of the present day reads of the wondrous water and more marvelous cures in an imposing list, as set forth in divers attestations from rejuvenated preachers, restored politicians and renovated bobbed-haired suffragettes, persons unqualified by study or experience to give valuable testimony, and then carefully studies the analysis and finds that it contains only an infinitesimal amount of lime salts in parts per 1,000,000, is it any wonder that he tosses it

into the waste-basket in disgust, and assuages his enraged intelligence with an expletive objuration on charlatanry in general, and the mineral spring mountebank in particular? This "cure-all" type of advertising, pursued by many proprietors of mineral springs has contributed largely to bring odium upon mineral waters, and to foster incredulity in the minds of the profession. A spring or spa exploiting a really meritorious mineral water, which has hopes for continuous patronage and endorsement of the profession, has no need to resort to exaggerated hyperbole nor to the use of superlatives.

**Dangers of Self Prescribing.**—Another hindrance to the scientific progress of hydrotherapeutics is the indiscriminate manner in which mineral waters are used, both by the individual self-prescriber and by the physician carelessly permitting patients to drink any waters which "somebody" says are "good." At every spring resort during the season we observe individuals imbibing, on their own initiative, large quantities of water from a powerfully mineralized spring without first consulting the attending physician, which is a serious blunder and liable to lead to disastrous consequences. Like every other remedy of any efficacy, mineral waters are susceptible of abuse and of exerting harmful influence where not indicated.

**Adjuvants to Spring or Spa Treatment.**—Again we occasionally find physicians, who, while admitting the beneficial effects of sojourn at a spring or spa with restoration to health, deny the curative effects of the waters in bringing about such benefits, and ascribe the recovery all to change of scene, climate, environment, travel, etc. These, no doubt, are contributing influences and not frequently all powerful agencies for the relief of many hypochondrical imaginative nervous ailments. How far the diseases of the hypochondriac, the melancholic and the overworked, are favorably influenced by a pleasant journey to a summer resort, and the mirthful society congregated there, it is impossible to determine. But these helpful influences of mineral water therapy will never modify or eradicate the gouty or rheumatic diatheses, they will not arrest the formation of calculi, they will not relieve irritation of the urinary tract and catarrh of the bladder, they will not dispel visceral engorgements, all of which the waters themselves will do.

**The Usefulness of Mineral Waters in Chronic Disease.**—Long experience of resort physicians emphasizes the fact that the greatest field of usefulness for these mineral agents is in chronic disorders. In acute diseases mineral waters are not suited, because, from their stimulating properties, they are prone to increase the activity of the circulation; but in chronic disorders they are found eminently serviceable. By chronic diseases are meant those attended by either simple excitement, chronic inflammation or chronic congestion. To secure beneficial results in diseases of this type, the use of the waters, like the disease, will have to be long continued, for weeks or even for months. It must be understood that instantaneous cure need not be expected,

but the remedy should be persistently and patiently administered, and the cure will gradually be brought about. Without question, a purgative saline water will promptly remove the symptom of constipation, while an alkaline bicarbonated water will at once relieve acid eructations, pyrosis and water brash; but to overcome the predominating causes underlying these conditions patience, perseverance and time will be required. The administration of the water, then, must be continued not only for a few days, but for a few weeks—eight, ten or twelve, as the case may be. There is no greater folly in the use of mineral waters than laying down a rule of a definite time for them to be used without reference to their physiological effects upon the system. Like all other medicines, mineral waters should be used, discontinued or modified in their dosage and usage, with a strict regard to their therapeutic action on the body and their beneficial or outward effects upon the disease. Whenever prescribed, their actions should be watched with the same care with which we note the action of any other drug; they should be continued, or temporarily or permanently discontinued or controlled in their action by some appropriate adjuvant, according to indications and as the progress of the case demands.

It is common experience with most overworked persons visiting a spring or spa during the summer months to feel almost from their arrival a lightness and buoyancy of spirit and a positive feeling of restfulness. General improvement in their physical condition, usually, rapidly follows, and after a stay of a month then return to their homes fully restored to health. This recuperation of health and buoyancy of spirit can be largely accounted for by change of air, food, climate and cheerful environment, with escape from the worries of business. Yet, after liberal acknowledgment for all these synergistic and helpful influences, we must justly render honor where honor is due, and attribute a large share of the good results to the aid of a properly selected mineral water. No question but that these changes and the use of the water supplement each other, and this explains the fact that mineral waters seem to be more efficacious when drunk at the spring than when taken at home. This is explained in part by the discovery of *radio-active* emanations in most mineral waters.

**Confidence of Profession in Mineral-water Therapy.**—An earnest presentation of the therapeutic properties and the scientific administration of a mineral water, based on its mineral ingredients, as shown by analysis, and attested by the experience of eminent physicians, should command the serious consideration of the unbiased practitioner and convince him that we have in these agents a valuable addition to the materia medica, and one that we may prescribe with the utmost confidence.

Mineral waters are not simple medicaments. Whatever may be the predominating mineral element in a given water as demonstrated by analysis, it acts not alone. Nature's alchemist, in combining the more or less notable elements, produces a compound which the materia

medica can at best only imitate. Besides, there are other exceedingly valuable ingredients and principles which are yet unknown but which have done for Nature's mineralized agent that which we attempt to imitate in our prescription when we prescribe a synergist to reënforce the action of some drug. Experience has taught us to make due allowance for the particular phenomena which may result from the action of certain elements which enter into the composition of a mineral water. In particular we have learned not to attribute to a single element, however dominant it appears in the analysis, all the curative properties of the water which clinical experience reveals.

It is easy to understand that a water heavily charged with magnesium sulphate will produce alvine discharges, and that one containing iron bicarbonate will increase the hemoglobin content of the red blood corpuscles; yet we must confess that an element of mystery still cloaks the action of many mineral waters, and the pleasing effects obtained from their administration are not easily understood. It is well known that a water containing a minute amount of sodium sulphate will often give relief in chronic torpidity of the bowels, while a water containing only 0.595 part per 1,000,000 of arsenic will soon produce the well-known physiological action of that powerful drug. It is also well known that a water containing calcium sulphate, 5.2 to 8.5 parts per 1,000,000 and a small amount of lithium bicarbonate will exert antacid, diuretic and solvent effects. These effects cannot be produced by artificial waters when they contain the same mineral elements in much greater proportion. The only explanation we may offer for the more potent properties of the natural waters is the fact that the mineral ingredients included in them are in a state of combination which the science of pharmacy could only imitate but never duplicate.

**Dissociation Theory of Mineral Salts.**—From the hydrolytic standpoint, an acquaintance with the laws which regulate saline solutions is of momentous importance, since a mineral water is an exceedingly complex inorganic body, whose properties are dominated by its physiochemical constitution. According to the ionic dissociation theory, a salt in solution forms an electrolyte and is completely split up into ions, and that, under the influence of true vibratory conditions, perpetual exchange of ions takes place from molecule to molecule; these ions vibrate, side by side, and, according to positive or negative influence, join with the ions of a neighboring molecule. These ions vibrate in the solution under the positive or negative influence of their electric charges. Therefore, it is fallacious to entertain the idea of a mineral water as an inert body; it represents, on the contrary, a real mineral species, complex, of course, but a perfectly balanced association of molecules and ions endowed with certain specific properties. These molecules and ions possess an electrical equilibrium, a positive attraction or a negative repulsion, and certain qualities of living forces; all of which come into play in the solution; the molecules

and ions react on one another in a multitude of exchanges and combinations, rapidly made and as quickly undone. A mineral water, like every complex solution, represents an essentially living medium, the knowledge of which is yet incomplete, but nevertheless highly interesting. Furthermore, in all probability, the ions rather than the undissociated elements *per se* are responsible in great part for the specific action of mineral waters; this dissociation theory explains, or at least gives an insight into, the pleasing effects obtained from the administration of mineral waters.

**Adaptation of Mineral-water Treatment to Disease.**—In prescribing mineral waters we are guided by the most prominent ingredients revealed by analysis, and we can never be absolutely certain but that substances present in much smaller quantities, *or even in infinitesimal traces do not play a more important role in the physiological action of the water, as a whole, than is generally conceded.* Chemical science has done much to put the administration of mineral waters above empiricism and on a safe and scientific basis of *clinical experience.* After all that science effects in determining the component parts of a mineral water, it is experience *alone,* from their use, that can be fully relied upon as to their specific virtue or applicability in a given disease. It is regrettable that there is a dearth of information, generally, and even among the more learned members of the medical profession, as to the specific nature and adaptation of mineral waters to particular diseases. The want of such information is not a safe and confident guide to the recommendation of these valuable medicinal agents.

## CHAPTER III.

## THE ORIGIN OF MINERAL SPRINGS AND THEIR SOURCES OF MINERALIZATION.

THE *origin of mineral waters* has been a subject of inquiry by scientists of all ages. From whence comes the great volume of water which issues forth through springs and which appears to be unfailing in its supply, changing but little in rate of flow from year to year and from century to century. For ages past the origin of mineral springs was a perplexing question and a fruitful subject of debate among ancient philosophers and alchemists, but it is now an accepted fact that the water of all springs, natural and otherwise, is meteoric in its origin. Aristotle taught that there were large cavities in the bowels of the earth filled with air, and that this imprisoned air condensed into water which found its way to the earth's surface through fissures. Vitruvius was convinced that springs were due to the accumulation of rain and melted snow which found its way into the subterranean reservoirs. Descartes propounded the theory that the sea was the source of the water which flowed into subterranean caverns, was vaporized and later condensed to water, and finally was forced upward through fissures in the rocky strata as springs.[1]

The water of mineral, and all other springs is no longer conceded as a new creation, but it is now acknowledged that the spring is only one of the constituent phases of an aqueous circulation that begins and ends in the clouds, which encompass the entire globe. The water is evaporated from the surface of streams, lakes and seas and, passing into the atmospheric air, forms the rain clouds from which it is precipitated and falls to the earth. The greater portion of the rainfall is revolatilized or drained away by the streams and again finds its way into the great reservoirs. A very large portion of the precipitation is absorbed by and sinks into the earth through fissures and crevices in its rocks, and after an indefinite subterranean career, issues forth upon the earth's surface as a spring, in some lower and more favorable level, and eventually reaches the ocean, whence, by evaporation it once again becomes a part of our cloudy envelope.

**Theories of Ancient Philosophers.** During the latter part of the Seventeenth Century Mariotte,[2] a French physician, and Halley, an eminent English astronomer, independently of each other, promulgated the same views and arrived at the same conclusions: That the rainfall, including snow and dew, was sufficient to supply all the water that flows from springs, lakes and rivers that supply water to the sea.

Buffon, working on the same theory, proved the hypothesis promulgated by Mariotte and Halley, that the evaporation of a lake without an outlet was equal to the water poured into it. It was once believed that all the rain water that was precipitated to the earth was at once absorbed and retained in the surface strata only a short distance below the soil, but the constant dripping of water from the roof of deep mines and subterranean tunnels upset this view. In Saxony there is a mine 1600 feet below the earth's surface where water drips constantly, and again the railroad tunnel through Mount Cenis, a mass of rock so hard as to turn the best steel, was found to be so filled with water that a canal had to be built through the center to drain it away. Professor Hunt has estimated that a square mile of sandstone 100 feet in thickness contains sufficient water to maintain a constant flow of $8\frac{1}{2}$ gallons per minute for thirteen years.[3]

Water falling on the earth's surface as rain or snow penetrates the strata below the top soil to a greater or less depth, and not infrequently it is subjected to an enormous hydrostatic pressure as it reaches lower levels, and when a favorable opportunity occurs, through a fissure or crevice in the rocks, this pressure forces it to the surface. Again, many springs flow out naturally, where the source is at a higher altitude than the outlet. In the case of hot springs, the water is forced to the surface by an accumulation of steam, or as geysers from the effect of steam at high pressure. The great majority of springs, however, reach the earth's surface quietly either at the foot of mountain ranges or at a greater distance in the valleys or near the tide-water areas. In all cases their supply is the rainfall received on the mountain regions or the hilly plains. This water, then, under ordinary circumstances, sinks into the earth until an impervious stratum is reached along which it flows until it finally emerges at a lower level, as an ordinary spring; or as a mineral spring, provided the rocks through which it passes, or the earth through which it percolates are charged with minerals; or as a hot spring if it comes from great depths, or comes in contact with heated rocks on its way to the earth's surface. It is the consensus of opinion that volcanoes and earthquakes occur at great depths below the earth's surface, and if great volumes of water are suddenly enchasmed or slowly filter into the interior of the earth by mazy circuitous channels, it is quite probable that, when superheated, they will be rapidly forced through the most favorable exit in the earth's surface in the form of thermal waters or saline springs.

**Sources of Mineralization of Mineral Waters.**—The sources of mineralization of mineral waters is a question more easily answered than the question of the origin of mineral springs. An examination of such a water will show that it has undergone various changes during its dark wanderings through the nether world. The rain water, to start with, is quite pure as it falls from the clouds, with the exception of a little ammonia, possibly nitrates and nitrites and a small amount of carbonic acid, oxygen and nitrogen gathered from the air in its

descent from the clouds. On its issuing from the earth as a spring, however, it may be charged with mineral ingredients ranging from a mere trace to many thousands of parts per 1,000,000 and, besides, it may be saturated with one or more gases. Whence the source of this mineralization? It has been truly stated that the analysis of a mineral spring points out the various geological strata which the water traversed, and also is an index to the mineral elements with which it has come in contact. "Water wears away a stone" is a true saying; water is the universal solvent. The disintegrating effect of fairly pure water upon rocks is well known, and when we recall that rain water, already containing a small amount of carbonic acid, acquired while passing through the atmosphere and the soil, which greatly enhances its solvent properties, we need not search far afield for the source of the constituents of mineral waters. Coming in contact with igneous and metamorphic rocks, it abstracts from them its important mineral constituents. If the water struggling along to find an exit passes over or through salt deposits, the spring will contain sodium chloride; while filtering through deposits of iron ore, it becomes ferruginous; percolating through limestone or marble, it will be charged with calcium salts. Even the most flint-like stone yields its quota to the potent solvent action of the aqueous current. It is not beyond a probability that further chemical action, and in some instances heat also, are employed by Nature in elaborating the chemical components of mineral springs. Besides,[4] water under great pressure, without the aid of chemical action alone, may dissolve not only the more soluble constituents of rocks, but others not usually so considered, as silica, which is sparingly soluble.

**Analyses and Results.**—It has already been stated that pure water possesses powerful solvent properties, unequaled by other fluids. No stone, however flinty or dense, can resist its continued action. Even drinking glasses which we use daily are dissolved by it, in minute proportions; when, in addition, the water is charged with carbonic-acid gas its solvent power on many substances is greatly increased.[5] While filtering through the sedimentary rocks a large proportion of the former deposited mineral constituents is redissolved, and together with the constituents of the metamorphic and igneous rocks will be found all of the solid constituents which analysis reveals in mineral waters. These various ingredients are readily recognized by the analytical chemist, as acids and bases and gases. These he combines according to accepted formulæ, and expresses his results as so many parts per 1,000,000 of calcium sulphate, or magnesium sulphate, etc. Unfortunately the combinations actually occurring in water are not simple and stable so as to permit an expression of exact combinations in which all of the ingredients occur, and on constructing his estimates the chemist is obliged to resort to some empirical or arbitrary method. He ascertains by his tests the various acid and basic "ions" existing in the water, and the amounts. He then calculates that they unite to

form salts, assuming a particular hypothetical mode of combination which is presented as the analysis.

It is quite impossible to ascertain and set down the exact arrangement of the elements found upon analysis. For instance, in a solution of solium chloride and potassium sulphate both sodium sulphate and potassium chloride are probably present in addition to the two original salts, as well as sodium, potassium, chloride and sulphate ions, and when, in addition, other substances by their presence render the situation more complex, the impossibility of determining with any degree of exactness the arrangement of the elements in water analysis is very apparent.

**Analyses: How Best Stated for Interpretation.**—On this account it has been argued that everything beyond the mere statement of the acids and bases being matters of hypothesis, nothing should be set down but their respective weights. While such a procedure might satisfy the chemist or geologist, but with the less technical knowledge of average physicians it is not sufficiently intelligible to them. They wish analyses to be so expressed that, from their viewpoint, the probable physiological effect upon the system may be anticipated, and therefore it is necessary for their clear comprehension of these points that the probable composition be stated. If at the same time the elements actually found are also given it would fully state the situation It is more than probable that the strongest acid will always unite with the strongest base, and to obtain an idea of the therapeutic value of a mineral water, even if only approximate, it is always desirable to state the probable combination. From the foregoing it is readily seen that the results of mineral-water analysis would be more valuable if this combining of the elements in their probable combination were always made upon a uniform plan. The correctness of the careful analyst's finding have been verified, of late years, in the case of many different springs, by the subsequent observations of the physiological action of the waters upon correctly diagnosed diseased conditions, which is helpful in arriving at an ideal (medicinal) classification of mineral waters.

**Reports per 1,000,000 versus Grains per Gallon.**—It is unfortunate that a more uniform system of stating the constituent components of mineral waters has not been agreed upon. As a matter of fact,[6] the analyses of mineral waters have been made upon almost as many plans as there have been chemists making the analyses. An examination of about 1000 analyses of mineral waters in the United States reveals at least forty methods of stating results. They range from parts per 100 to parts per 1000, per 10,000, per 100,000 and parts per 1,000,000; from grains per cubic inch, to grains per pint; from grains per quart to grains per gallon; so many milligrams per liter, which would be the same as parts per 1,000,000, provided the liter always weighed exactly 1000 gm. In some instances only the elements actually found are recorded, and in others only the probable combinations. Again, others

give only the radicles found, while in a number of instances the analyses are only qualitative, no attempt being made to report quantities. In order to clarify this chaotic state of affairs we have adopted the recommendations of the Chemical Society of Washington,[7] and the standards promulgated by the Water Laboratory[8] of the United States Department of Agriculture. The various solids are given as so many parts per 1,000,000, and the gases as so many cubic centimeters per 1000 gm. at 0° C. and at 750 mm. pressure. All analyses are stated in the hypothetical combinations deemed most probable by both name and symbol.

It has been held for many decades by all of the older writers that the statement "grains per gallon" presents a more definite idea than "parts per 1,000,000." Yet if one will stop to inquire he will realize that, aside of chemists and pharmacists, the idea as to what a grain of any given substance means is more or less indefinite and indistinct. Besides, grains per gallon are incommensurable quantities, whereas parts per 1000, per 10,000 and per 1,000,000 are definite and distinct and readily understood; in harmony with, what we hope will eventually become the universal method of stating the component chemical constituents of mineral waters.

**Quantitative Analyses.**—With the quantitative analysis before us, and a knowledge of the capacity of the patient's drinking glass, we can rapidly calculate with fair accuracy the amount of the predominating chemical constituents the patient is receiving daily. With the exception of a few of the more powerfully mineralized springs, concerning which specific instructions should always be given, it is of no particular importance to be so specific as to the dosage of mineral waters, as a few glasses more or less is of little consequence.

**Conversion and Recalculation of Analyses.**—It is sometimes desirable to convert an analysis from one form to another, and directions for recalculating an analysis may not be out of place. Since the weight of a stated volume of water varies according to its density and temperature, the value of a stated volume, even a wine gallon, is somewhat indefinite unless these factors are stated. The following table shows these variations:

Apparent Weight of Water at Different Temperatures.

| | Temperature of air, 62° F.; temperature of water, 39.2° F.; 1 cu. in., 252,761 gr. | | Temperature of air, 62° F.; temperature of water, 59° F.; 1 cu. in., 254,554 gr. | | Temperature of air, 62° F.; temperature of water, 62° F.; 1 cu. in., 252,488 gr. | | Temperature of air, 71° F.; temperature of water, 71.6° F. | |
|---|---|---|---|---|---|---|---|---|
| | Grams. | Grains. | Grams. | Grains. | Grams. | Grains. | Grams. | Grains. |
| One liter | 999,512 | 15,424,831 | 998,695 | 15,412,215 | 998,435 | 15,408,204 | 997,500 | 15,393 |
| One U. S. gallon | 3,783,466 | 58,387,855 | 3,780,371 | 58,340,011 | 3,779,387 | 58,324,827 | 3,776 | 58,270 |
| One imp. gallon | 4,540,820 | 70,075,500 | 4,537,199 | 70,018,111 | 4,555,926 | 70,000,000 | 4,532 | 69,934 |

The United States Pharmacopœia defines the United States gallon to comprise 231 cubic inches, and the *Century Dictionary* states it is equal to a cylinder 7 inches in diameter and 6 inches high, weighing 8.3389 pounds avoirdupois at its greatest density, weighed in air at a barometric pressure of 30 inches and a temperature of 62° F., is equal to 3.7855 liters of water.

The following conversion table is given by Leffman and Beam.[9]

| | | | |
|---|---|---|---|
| Parts per 100,000 | × 0.7 | = | grains per Imperial gallon |
| Parts per 1,000,000 | × 0.07 | = | grains per Imperial gallon |
| Parts per 100,000 | × 0.583 | = | grains per United States gallon |
| Parts per 1,000,000 | × 0.0583 | = | grains per United States gallon |
| Parts per 1,000,000 | = 0.00583 | = | number of pounds per 1000 U. S. gallons |
| Grains per Imperial gallon | ÷ 0.7 | = | parts per 100,000 |
| Grains per Imperial gallon | ÷ 0.07 | = | parts per 1,000,000 |
| Grains per U. S. gallon | ÷ 0.583 | = | parts per 100,000 |
| Grains per U. S. gallon | ÷ 0.0583 | = | parts per 1,000,000 |

The reduction from the Imperial gallon to the United States gallon is made by multiplying 0.833. To change the United States gallon to the Imperial gallon multiply by 1.19. The following is for the reduction of grams per liter to grains in the United States gallon:

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | gm. per | liter | = | 58.41 | gr. per United States | gallon |
| 2 | " | " | = | 116.82 | " " | " |
| 3 | " | " | = | 175.23 | " " | " |
| 4 | " | " | = | 233.64 | " " | " |
| 5 | " | " | = | 292.05 | " " | " |
| 6 | " | " | = | 350.46 | " " | " |
| 7 | " | " | = | 408.87 | " " | " |
| 8 | " | " | = | 467.28 | " " | " |
| 9 | " | " | = | 525.69 | " " | " |
| 10 | " | " | = | 585.10 | " " | " |

To change grains per gallon to parts per 1,000,000 multiply by the factor 17.118 for all component constituents except carbonates, which must first be calculated to bicarbonates.

In connection with the formation of mineral springs, certain peculiar phenomena occur which need further consideration, viz:

**Ascending Springs.**—Ascending springs are those in which the water is elevated from a point below by hydrostatic pressure. Rocks composed of highly crystalline gneiss, granite and syenite are almost impervious to water. This class of rocks are called Laurentian rocks. All rain falling above a fissure in such an area except that which passes off as surface water, permeates the different strata until it meets the Laurentian rocks; thence it passes over the surface of these rocks until the fissure is reached, where it comes in contact with the uplifted rocks and accumulates. From the fissure in this flinty rock basin, which is at unknown depths, carbonic acid doubtless arises, and thus, in addition to its solid ingredients, the water becomes highly charged with this gas. The continual accumulations of water and the pressure of the gas together force the water to the earth's surface, where

it bursts forth in various springs. Again, where the hydrostatic pressure is very high, and the imprisoned water is suddenly liberated, as in the artesian well, the water escapes with great force, being projected high above the earth's surface. The Tuscan Springs of California belong to the class of ascending springs; the water emerges from a crevice between strata thrown up by volcanic action. The temperature is 34.4° C. (94° F.) and contains large quantities of sulphuretted hydrogen.

**Descending Springs.**—Descending springs are found at the base of hills and mountains, and are usually of such low mineralization that they are rarely classed as mineral springs. However, they contain very pure and wholesome drinking water. The water of such springs is supplied by the rainfall, snow and ice which falls or forms on the mountains. Owing to the direct source of water supply, they are more susceptible to variations in flow than other springs. During the rainy season, or after the spring thaws the rate of flow will be greatly increased. The Rockbridge Alum Springs in Virginia is an excellent example of the descending spring. The waters of these springs issue forth at the base of a mountain range, which rises almost perpendicularly to great heights.

**Intermittent Springs.**—Intermittent springs, as the name signifies, flow at regular intervals, once or twice a year, for a period of eight to twelve weeks, or it may be, for a short period daily, or even every hour. The cause of this intermittent flow, in the first instance, is due to seasonal influences—irregularity of rainfall or to the melting of ice or snow on the mountain ranges. Many glaciers pour out water only during the summer, while others supply water only at midday while the sun is sufficiently hot to melt the ice which supplies the flow of water. Several of the artesian springs at Saratoga, particularly the Champion and Geyser Springs, show an intermittent, spouting character. The American Carlsbad Springs and the Washington Springs in Illinois exhibit eccentric behavior at or about the autumnal equinox. The waters become turbid at this time, and similar disturbances have been noticed after severe storms or volcanic disturbances, even at remote distances from the springs. Near Roanoke Red Sulphur Springs in Virginia is located the celebrated "Flowing Spring," which flows twice each day for about an hour at a time, and then suddenly stops. These alternating outflowings and remissions were once thought to be influenced by the rise and fall of the tides.

**Thermal Springs.**—Thermal springs whose temperature reaches 21.1° to 36.7° C. (70° to 98° F.) are tepid, and above that, are hot. Strictly speaking, all springs whose temperature is higher than that of the mean annual temperature of their immediate locality are thermal. Thus, springs in Alaska or Siberia, where the earth is constantly frozen to a depth of several hundred feet, and the waters have a temperature of 0° to 5.6° C. (32° to 42° F.) and never freeze, are warm springs, while a spring with the same temperature in the West Indies

or along the Equator would be a cold spring. All thermal waters are subdivided and classified the same as the non-thermal. They may be bicarbonated, sulphuretted, etc., alkaline, saline, alkaline-saline and, other things being equal, they may contain the same mineralization as non-thermal waters; besides, a thermal spring is a better solvent than cold water. The fact, a spring is thermal depends somewhat upon its geological location. The rocky strata in which they originate are not usually readily disintegrated, as are the more soluble sedimentaries. Where both hot and cold waters occur in the same geological locality, we find little or no great differences in the quantities of total solids. At the Virginia Hot Springs, for instance, one of the springs has a temperature of 25.5° C. (78° F.), with total solids of 310.29 parts per 1,000,000, and another with a temperature of 44.3° C. (110° F.) with total solids of 572.21 parts per 1,000,000. The cause of the heat of thermal springs is to be found in their proximity to, or their source in, rocks of volcanic or igneous origin; in their occurrence in areas of mountain corrugation or of profound dislocations; or, if they come from great depths, from the normal downward increase of the temperature of the earth in its lower regions. California and the regions traversed by the Rocky Mountains has many thermal springs, while the South and East have but few. In the Middle or New England States is the Lebanon Thermal Spring of New York, with a temperature of 24.4° C. (75° F.). Several of the springs at Saratoga have a higher temperature than the circumambient atmosphere, but cannot be classed as warm. The Virginia Hot Springs, 44.3° C. (110° F.), and nearby the Warm Springs, 35.6° to 36.7° C. (96° to 98° F.), the Hot Springs in North Carolina, 33.3° to 47.2° C. (92° to 117° F.), and the Warm Springs in Georgia, 21.1° to 32.2° C. (70° to 90° F.), and the celebrated Hot Springs of Arkansas, 24.4° to 69.6° C. (76° to 157° F.) are a few of the leading hot springs east of the Rocky Mountains. The San Bernardina Hot Spring, in California, has a temperature of 77.8° C. (172° F.), while the great geyser in the Yellowstone National Park has a temperature of 92.6° C. (199.8° F.), and the Steamboat Geyser Springs in Sonoma County, California, has a temperature of 100° C. (212° F.), the waters of the latter escaping as steam. It is interesting to note that the temperature of the Virginia Hot Springs, the North Carolina Hot Springs and the Arkansas Hot Springs show little change during recent years, the slight variations found being due, no doubt, to discrepancies in the thermometers used.

The General Electric Company[10] has just reported tests conducted by their engineers at Geyser Canyon in Sonoma County, Cal., which reveals natural steam generated hundreds of feet below the earth's surface. There is already an 8-inch pipe sunk to the depth of 200 feet, through which the steam at 162.2° C. (355° F.) is harnessed to a 35-kw. turbine engine, which furnishes energy for light, heat and power for a town of 2000 people. According to accepted theories, the steam comes from an underground cavern of vast extent, which has a layer of spongy

rock for a floor, supported by a tremendous seething mass of molten white-hot lava. Water, continuously seeping down through a number of passages, percolates through the porous rocks and is transformed by the intense heat into steam under the pressure which rises into the cavernous chamber. From this chamber steam was discovered escaping through cracks in the earth's surface, and the 8-inch pipe was installed and the steam harnessed and transformed into electrical energy, as above stated.

## THE INTERIOR HEAT OF THE EARTH.

The thickness of the earth's crust varies considerably, and the heat is not the same in all localities. Therefore, we cannot accurately judge the depth of a spring by the heat of the water; still, it is a well-known fact, verified by the sinking of artesian wells, and the drainage of mines, that there is an increase of temperature as the descent increases. It was formerly supposed to average −16.2° C. (1° F.) for every 55 feet of depth. Some years ago Dr. William Hallock,[11] of Columbia College, of the City of New York, reported his observations on the deep well at Wheeling, W. Va., and recorded that down to the depth of 3200 feet the gradient was −16.2° C. (1° F.) for every 81½ feet, whereas the last few hundred feet showed an increase of −16.2° C (1° F.) for every 60 feet. Other influences also serve to render the approximate depth of a hot spring uncertain. The water from a great depth may mingle with colder water in a stratum above, or, again, a vein of water supplying a well of moderate depth may have its origin far below.

**Chemical Action.**—Chemical action, according to Peal,[2] plays little, if any, part as a cause of the source of heat in mineral springs. On the contrary, Winslow Anderson[12] avers that chemical action may under favorable conditions raise the temperature of water to 100° C. (212° F.). It is well known that while certain chemical actions produce a fall in temperature, there are many which evolve heat to a high degree. Sulphur, as we know, may be oxidized to sulphur dioxide ($SO_2$)., giving rise to considerable elevation of temperature. This substance dissolved in water forms sulphurous acid ($H_2SO_3$), which on further oxidation changes to sulphuric acid ($H_2SO_4$), heat being further increased. If this powerful acid comes in contact with limestone or other carbonates still more heat is liberated, together with the evolution of carbon-dioxide gas ($CO_2$).

**Volcanic Action and Mountain Corrugation.**—It is a well-known fact that the greater number of hot springs in all parts of the world are found in volcanic mountainous districts. Notwithstanding outbreaks may not have occurred in centuries, still evidence of their former activities may be observed by the presence of old craters, lava beds

and rugged corrugations. In volcanic areas less violent, secondary phenomena, such as hot springs, geysers and fumaroles emitting smoke, attest the slumbering fires below. Water coming into close juxtaposition with these thermal volcanic rocks in the nether world often attain a very high degree of temperature. In the region of the great Rocky Mountains, as well as in other sections of the far West, there are evidences of more recent volcanic eruptions than in the Appalachian chain of mountains in the eastern section of the United States. This fact accounts for the greater number of hot springs in the Rockies than in the eastern section of our country.

**Geysers.**—Geysers are peculiar, intermittent spoutings of hot springs, which derive their name from the famous geyser in Iceland. This eruptive hot spring shoots water upward with a loud roar to a height of 100 feet. A true geyser has an underground passage communicating with a source of water supply usually terminating at the surface of a basin built up and rimmed in by the deposition of sinter. In the Yellowstone National Park there are more than 100 geysers. Some of them shoot boiling water into the air to a height of 250 feet, accompanied by weird sepulchral wailings which reverberate in the surrounding earth. The commonly accepted theory of geyser formation, propounded by Benson, holds to the opinon that a geyser formation must consist of a natural tube more than 60 feet in depth, formed from earth, rocks or deposits from water itself. When such a tube is filled with water the pressure exerted on the column of liquid at the bottom increases to the boiling-point, with the evolution of steam, but the bubbles passing upward reach the cooler water above and are at once condensed. As succeeding layers of superincumbent water become gradually heated the boiling-point is reached and the bubbles are in turn condensed higher up in the tube. This continues, reaching higher and higher up the tube until the entire column of water is superheated. When, at last, the entire column of water is seething steam, then an explosion occurs, and we witness the wonderful, beautiful and impressive exhibitions of these fantastic freaks of Nature.

**Furmaroles.**—Furmaroles are holes or small apertures in the earth, observed in volcanic regions from which smoky, vaporous fumes arise. These freaks of Nature are numerous at the geysers of Steamboat Springs in California.

**Solfataras.**—Solfataras are quite numerous in the old volcanic regions of Italy. The sonfriers on the Island of St. Vincent is the most notable example of a solfatara, which at times becomes violently eruptive. The term solfatara means an area or place of latent volcanic eruption characterized by the discharge of steam and various gases, carbon dioxide, sulphuretted hydrogen and hydrochloric acid, usually without explosive effects. Phenomena of this character are observed in the neighborhood of several of the hot spring localities in the far West.

## VIRGIN AND VADOSE WATERS.

In Virgin and vadose waters the question of discriminating between magmatic, metaliferous, or volcanic waters (Virgin), and waters of superficial, vadose origin is a question for the geologists to answer. Modern investigations have thrown light upon the subject. Suess[13] presents arguments to show that waters from metaliferous veins and all waters arising from great depths are Virgin or "juvenile" waters coming from the fundamental magma itself, laden with metallic salts. This subdivision of springs into "Virgin" water, arising from magmatic or metalifeous sources, and "vadose" water, arising from superficial origin,[14] has had a rather wide, but not universal acceptance. The principal difficulty in applying the proposed nomenclature is the fact that it is not an easy matter to determine the source or origin of the water of a given spring. Gautier[15] has shown that "Virgin," or juvenile, waters of magmatic origin are fairly constant in composition, concentration, rate of flow, temperature, etc., and are not influenced by precipitation, and carry sodium bicarbonate, alkaline silicates, the heavy metals and the rarer elements as chief constituents, with chlorides or sulphate only as accessories. On the contrary, "vadose" waters are waters of infiltration, characterized by fluctuations in composition, concentration and rate of flow, and are dependent upon precipitation and variable meteoric conditions; they carry in solution, as a rule, bicarbonates of calcium or magnesium, chlorides and sulphates as chief constituents. Vadose waters more often issue from faults having no relation to the metallic veins of the adjacent surroundings. Gautier further argues that hydrogen evolved and emitted from the boiling bowels of the earth acts as a reducing agent upon metallic oxides and so forms the magmatic water of the springs. A fault or fissure in granite or other igneous rock may be miles in depth, and the waters after circulating in the nether world for untold centuries issues forth to see the light of day—as Virgin waters—and are always radio-active and contain rare and beneficial chemical constituents not found in vadose waters. If a water starts upward from a fault in igneous rock and later passes through sedimentary rock then the water will show the fact by containing mineral matter common to water of sedimentary origin. If coming from igneous sources and becoming mixed with superficial water, or reaches a strata fed by local rainfall, the value of the original "Virgin" water is lessened and its therapeutic constituents diluted. Scharz[16] and others controvert the theory of Suess,[17] by holding that the waters from volcanoes and hot springs do not come from the original magma, but are of vadose origin, and that the heat can be accounted for by assuming sudden pressure or stress in the earth's crust, the resulting energy being changed into heat. Whether the hot springs and geysers in our own country, notably in the great Rocky Mountain region, may not be of vadose origin remains for future geological research and investigation to determine.

## THE PHYSICAL CHARACTERISTICS OF MINERAL WATERS.

The physical characteristics of mineral waters differ in many respects from potable waters. Mineral waters when examined in a glass are usually clear and transparent, like crystal.[18] They also appear colorless, but when looked down on in a spring, or after they are pumped into reservoirs, they frequently present to the eye a greenish, opalescent hue, an optical effect due to their density. On the other hand, they may exhibit other tints of color due to mineral substances which they contain in solution in impalpable division. For instance, the whitish appearance frequently observed in sulphur waters is due to suspended sulphur; the yellow tinge is due to the change of a monosulphide into a polysulphide. Again, a pure white tint or shade may be, and often is, due to the suspended calcium carbonate, while a bluish color arises from the suspension of slate or clay in minute subdivision. The reddish tint in some ferruginous waters is due to the suspension of the red oxide of iron, but in some instances that tint may be due to microscopic algæ of that color.

**Odor.**—Odor is a physical characteristic of certain mineral waters and may be due to the soil through which it flows, or to the gases with which it is charged, or to its mineralization. Sulphur waters always have the predominating sulphuretted hydrogen smell, which many times can be detected at great distances from the spring. Sulphur waters containing the monosulphide of sodium, in the absence of hydrogen sulphide gas, do not present an objectionable odor. Waters heavily charged with calcium sulphate may discharge hydrogen sulphide through the reduction of the sulphate by organic matter.

**Taste.**—The various sulphur waters possess a more decided taste than any other class. The character of a mineral water, generally speaking, can seldom be determined by taste, except the sulphur group, and, perhaps, after all, it is not taste, but the odor of the hydrogen sulphide rendered more perceptible on swallowing. Besides, these waters are generally bitter to the taste, due to the predominating constituents, the sulphate of sodium and magnesium or the chloride of magnesium. Alkaline waters carrying the alkaline bicarbonates possess a particular taste, which is diffiuclt to describe, except as an alkaline taste. Such waters frequently evolve large quantities of carbonic acid gas which introduces a pungent agreeable taste factor. Saline waters possess the characteristic of table salt, which is frequently obscured by large proportions of carbonic acid. Ferruginous waters, other than the bicarbonated, have a decided styptic, ferruginous taste. Calcic waters are often slightly alkaline to the taste, more especially if they contain large quantities of calcium bicarbonate, when they may have an unctuosity soft as oil.

**Texture.**—The texture of water is a quality imparted to the skin, varying from harshness to smoothness. It is particularly noticeable in some waters as a bland soft feeling. Certain waters possess a

smooth texture in a very marked degree. The body when immersed in a full tub has a feeling as of being covered with a bland oil; the fingers while gently rubbing the surface have an unctuous smoothness imparted to them, as though they were anointed with some bland oily substance, and this peculiar pleasing sensation of smoothness remains quite a while after leaving the tub. The cause of this suave unctuousity is attributed to the presence of alkalinity, especially when due to alkaline silicates in large proportion and, in exceptional instances, to the monosulphide of sodium. Some observers have pointed out this bland unctuousness arises from a combination of the acid secretions from the cutaneous surface of the body, and the chemic bases of the water uniting to form a soapy mixture.

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## CHAPTER IV.

## THE CLASSIFICATION OF MINERAL WATERS.

By ERNEST ELLSWORTH SMITH, Ph.D., M.D.

The classification of waters on the basis of their mineralization is primarily a chemical problem. However, practical considerations based upon their physiological and pharmacological qualities make necessary certain limitations of such chemical classification when waters are considered as nutrient and therapeutic agents. Accordingly, we shall first present the subject from a strictly chemical viewpoint and subsequently direct attention to the limitations and modifications of the chemical classification when mineral waters are to be considered as medicinal agents.

### CHEMICAL CLASSIFICATION.

On the basis of the dominating ingredients, we recognize six major divisions:

**I. Alkaline Waters.**—Alkaline waters are characterized by the relatively large proportion of their mineral ingredients that are capable of entering into combination with acids. Such reacting ingredients are combinations of the ions of the alkali or alkali-earth metals* on the one hand, usually with the bicarbonic ion on the other. If the bicarbonates are those of the alkali ions, namely sodium and potassium, in the absence of carbon-dioxide gas in the water they will display a weak alkalinity to litmus. If the bicarbonates are those of the alkali-earth ions, namely magnesium and calcium, they will display little or no alkalinity to litmus, notwithstanding that they exercise the same antacid action as do the alkali bicarbonates. Many times both the alkali and alkali-earth bicarbonates are present, yet even more frequently it is the latter alone that constitute the antacid ingredients. Relatively infrequently, carbonates of the alkali metals constitute the neutralizing ingredients of a water. In such waters alkali earths are not present, since they are insoluble in water containing carbonates. Even more infrequent are waters where alkalinity is due to borates or silicates, yet in certain alkaline waters these compounds of the alkalies do contribute appreciably to the alkalinity.

**II. Alkaline-saline Waters.**—Alkaline-saline waters constitute a large class of waters in which the ingredients of both Groups I and III, as

* The term alkali-earth metals is here used to indicate particularly magnesium and calcium. These are frequently inaccurately designated as earths by writers. Aluminum is a true earth.

outlined, are present in such quantities as to give the chemical characteristics of both of these groups to the waters in question. Hence, this division is recognized as an intermediate or connecting division.

**III. Saline Waters.**—Saline waters are characterized by the presence of predominating quantities of neutral combinations of the alkali or alkali-earth ions usually with the chlorine or sulphuric ions, the resulting salts being sodium or potassium chloride or sulphate, magnesium chloride or sulphate and calcium chloride or sulphate. Sodium chloride, sodium sulphate, magnesium sulphate and calcium sulphate are the ingredients of most frequent occurrence. Other ions that in exceptional instances occur in considerable quantities in combination with the alkali or alkali-earth metals are the nitric and phosphoric ions.

**IV. Acid Waters.**—Acid waters are quite distinctive and are a small group characterized by the presence of minerals other than gaseous ingredients, that are capable of neutralizing alkalies. By far the most frequent are those whose acidity is due to the presence of aluminum sulphate, the so-called alum waters. Exceptionally, natural waters occur, especially in volcanic regions and in mines, containing free hydrochloric or free sulphuric acid.

While all waters fall into these various classes, it happens that certain waters contain substances that present distinctive features and lead to the recognition of such waters on the basis of such features, rather than on the basis of the actually dominating ingredients which would place them in one of the four divisions already described.

**V. Iron, Ferruginous or Chalybeate Waters.**—Iron, ferruginous or chalybeate waters contain ferrous salts that either tend to separate out when such waters are removed from the source or at least signify their presence by the styptic taste.

**VI. Sulphur or Sulphuretted Waters.**—Sulphur or sulphuretted waters are impregnated with hydrogen sulphide gas which declares itself by its distinctive odor. While waters so impregnated may present the mineralization of one of the foregoing classes, yet the conspicuous nature of hydrogen sulphide impregnation leads to their recognition as sulphuretted or sulphur waters.

**Qualifying Characteristics.**—Waters belonging to the above classes may also present distinctive qualifying, although not dominating, chemical features. Thus, there are bromidic, iodic, arsenic, phosphoric, aluminic, lithic and manganic qualifications of particular waters, dependent upon the presence of appreciable though relatively small amounts of the corresponding mineral ingredients. Also carbon-dioxated, azotized, carburetted or oxygenated waters from the impregnation of particular waters with the corresponding gas. To this list must also be added radium emanations.

All of the above facts may be incorporated in the following scheme of classification of dominating ingredients, with qualifying ingredients following, always remembering that when present in relatively small amounts dominating become merely qualifying ingredients.

Divisions are indicated by Roman numerals:

*Dominant Ingredients.*

| | − ions. | + ions. | Gases. |
|---|---|---|---|
| I. Alkaline | Bicarbonic, Carbonic, Boric, Silicic | Sodium, Potassium, Magnesium | |
| II. Alkaline-saline | | | |
| III. Saline | Hydrochloric, Sulphuric, Nitric, Phosphoric | Calcium, V. Iron | VI. Hydrogen sulphide |
| IV. Acid | Hydrochloric, Sulphuric | Aluminum | |

*Qualifying Ingredients.*

| | | |
|---|---|---|
| Hydrobromic | Lithium | Carbon dioxide |
| Hydroiodic | Manganese | Methane |
| Arsenic | | Nitrogen |
| Aluminic | | Oxygen |
| | | Radium emanations |

## MEDICINAL CLASSIFICATION.

When mineral waters are considered as medicinal agents it becomes necessary to qualify the chemical classification to adapt it to the viewpoint of their medicinal values. This has to do both with the particular values of the mineral-water ingredients and with the matter of dosage. While much has been said and written on these aspects of mineral waters, chiefly on the one hand in the direction of claims of virtue mainly based on the empirical use of the waters and, on the other hand, in criticism of such claims as extravagant or even unwarranted, we know of few, if any, serious efforts to systematically consider the subject. It may probably be truthfully stated that, even with our present information, adequate knowledge may still be lacking for a complete and final presentation of the subject whether from the chemical or pharmacological and therapeutic viewpoint. However, much is known and there is no reason why a helpful beginning of such systematic consideration should not now be made.

**Composition and Medicinal Value.**—As a first consideration, is it possible from its known chemical composition to state with even an approximate degree of definiteness when a mineral water may be properly regarded as a medicinal agent? For, perhaps unfortunately, waters of an absurdly low mineralization dependent upon lay reputations of curative virtues are in certain instances lauded as agents of great curative potency. If it were known with certainty that we had a complete knowledge of all of the ingredients of natural waters and, further, if it were known that they were present merely as solutions equivalent to those obtained by dissolving corresponding salts in pure water, it would go far toward justifying from the

known composition definite conclusions as to curative potency. The writer at one time held to the view that adequate facts were known so that we could state with certainty that definite and final conclusions in the matter were justified. However, the subsequent discovery of radium emanations of curative potency as constituents in certain waters, the appreciation that certain ingredients may be present in colloidal rather than ordinary chemical solution and even more recently the knowledge that the absorption of ultra-violet light waves may impart to substances qualities of very great biological values, advances such as these have made necessary a more conservative view of our ability to evaluate with absolute certainty a mineral water from its known chemical composition and appear to demand that more weight than formerly seemed necessary or justified be given to claims of curative value that are supported by the testimony of intelligent and disinterested experience. But in giving weight to such opinions, it must be realized that great caution is necessary, since without constant vigilance it opens the door to wholly unjustified claims. As a matter of expedience, it is well to hold to the position that a full knowledge of the composition of a water as at present available does reveal the basis of its medicinal value and to depart from this position only when the evidence of experience that suggests a different conclusion is strongly convincing. Mere claims, based upon the casual use of a particular water, however sincerely made, do not alone constitute such evidence. We may conclude then that, as a rule, with possibly exceptions, we are able to state, with a reasonable degree of definiteness from a comprehensive knowledge of the composition of a water whether, and the extent to which, such a water is possessed of medicinal virtues.

**Degree of Mineralization Determining Medicinal Value.**—As a second consideration, we may question what degree of mineralization justifies classing a water as a medicinal mineral water. Beyond question, water itself, without regard to any mineral ingredients, is a therapeutic agent of very considerable value. While it is true that when brought into contact with isolated and thus unprotected body cells, pure water produces certain osmotic changes that when excessive may result in deleterious effects, as in the laking of blood, yet when water is ingested into the body through normal channels no such effects are produced, chiefly because the salines of the body are rapidly passed into the water, thus bringing its osmotic concentration into harmony with that of the cells with which it comes into contact. Nevertheless, in the very accomplishing of this, water exerts a stimulating action, increases and aids the digestive action of saliva, increases the flow of gastric juice, including its acidity and enzymic constituents, hastens, certainly at times anyway, the passage of the stomach contents through the pylorus, increases absorption from the intestines and through an increase of peristalsis tends to favor evacuation of the lower bowels. This latter action is augmented when water is taken into the empty stomach and at a temperature a little above that of the body when it

likewise acts as a diaphoretic through dilatation of the cutaneous vessels. It also stimulates the secretion of bile, pancreatic and intestinal juices. An indirect and yet very advantageous effect is the dimunition of intestinal putrefaction and hence lessened intestinal toxemia. After absorption, water stimulates osmosis from the body cells, thus increasing the removal of saline and metabolic end products and increases the normal body secretions, perhaps most markedly of the kidneys, upon which its diuretic action is often very pronounced.

Hence, when we state that a certain degree of mineralization is required to justify the designation mineral water, in the medicinal sense, it is not to be understood that waters not so classed are devoid of medicinal value, but rather that such value rests more particularly in the water itself, rather than in its mineralization. Doubtless, claims of therapeutic virtue are many times quite justified on this ground, it probably being beyond question that beneficient effects are produced by the systematic and augmented ingestion of water, as such, with its general stimulating and eliminating effects, as noted, and particularly so if there is added to this corrections of habits of eating and living. To deny the value of such "water cures" would be both incorrect and unfair. However, it is equally erroneous to ascribe such results to mineralization that is so insignificant as to be practically lacking. That is to say, while they may in a sense be properly designated "water cures," they may not be designated "mineral-water cures."

**Outline of Scheme.**—The following form of medicinal classification indicates the nature of the constituents by the various well-known terms—total, meaning total mineral ingredients, alkalinity, salinity, sulphated, etc. It further indicates varying degrees of quantity first by assigning definite values to terms descriptive of quantity, viz: very weak, weak, medium, strong, etc., and second by figures indicating multiples of these values. As an alternative for expressing this information in condensed form, especially useful in tabulation, it is pointed out that the dominant constituents may be indicated by symbols and the terms expressing quantity by the familar plus and minus signs which are to be interpreted in the manner to be described. Since the form of combination of the ions in solution is to a degree conjectural, that used by Haywood and Smith[1] is adopted.

**Numerical Values of the Qualifying Terms in the Medicinal Classification.**—Usage sanctions the employment of the terms very weak, weak, medium, strong and very strong to describe waters according to the quantities of the contained minerals. In order to give definiteness to these terms, the writer adopts the following numerical values, namely, for very weak, 0.08 gm. per liter; weak, 0.4 gm.; medium, 2 gm.; strong, 10 gm.; very strong, 50 gm. Considering for the moment merely the question of total mineralization, this in general covers about the range of mineral solids in various mineral waters to which we ordinarily are justified in ascribing medicinal qualities by reason of their min-

eralization. It is convenient that these values approximately correspond to $\frac{1}{5}$, 1, 5, 25 and 125 grains, respectively, per 5 fl. oz., a moderate drink of water. The accurate values are respectively 0.18, 0.92, 4.6, 22.8 and 114 gr. per 5 fl. oz. The term very weak is used only for certain particular qualities. The usual features are not recognized in greater dilution than weak. In the sense thus indicated, a water ordinarily ceases to be a simple potable or drinking water when it possesses as much as 0.4 gm.* of mineral solids per liter (or 1 gr. per 5 fl. oz.), and is accordingly designated a weak mineral water. When the mineral solids occur in five times this amount, namely 2 gm. per liter (or 5 gr. per 5 fl. oz.) such a water is no longer weak, but presents a medium degree of mineralization, and so on, through the various stages, the designation strong beginning at a point five times the beginning of medium and very strong five times the beginning of strong. A greater degree of exactness is given to these terms by the use of a numerical factor following the particular terms. For example, weak 2 would be interpreted as indicating twice 0.4 gm., that is, 0.8 gm. per liter (or 2 gr. per 5 fl. oz.); weak 3, 1.2 gm. (or 3 gr. per 5 fl. oz.); weak 4, 1.6 gm. (or 4 gr. per 5 fl. oz.). These ideas may be tabulated as follows:

| Designation. | Signs. | Mineralization. Grams per liter. | Mineralization. Grains per 5 fl. oz. |
|---|---|---|---|
| Very weak | −− | $0.08 \times n$ | $\frac{1}{5} \times n$ |
| Weak | − | $0.40 \times n$ | $1 \times n$ |
| Medium | | $2.00 \times n$ | $5 \times n$ |
| Strong | + | $10.00 \times n$ | $25 \times n$ |
| Very strong | ++ | $50.00 \times n$ | $125 \times n$ |

The value $n$ will be 1, 2, 3 or 4, according to the amount of the particular mineralization. The signs are employed merely to indicate the position below or above the designation medium and not to express any algebraic relation. Their use obviates the necessity in tabulation of employing the designation weak, strong, etc., but these terms give to the casual reader of the text unfamiliar with the system some notion of the relative strength of a given water which the signs do not.

The numerical values of the terms very weak, weak, medium, strong and very strong without qualification makes possible an error of 67 per cent. With the use of the integral multiplication factors, the possible error is reduced to 33 per cent. These extreme errors occur only in exceptional instances. With the more commonly occuring mineral concentrations, even such errors are not misleading. However, in the particular instances in which they occur, and especially with waters of high mineral concentration, these errors may be greatly reduced by the use of a multiplication factor carried into the first decimal place, *e. g.*, 2.6 instead of 3 in Mount Clemens water, since $50 \times 2.6$ is 130, while $50 \times 3$ would be 150, the exact amount being 128.65. This reduces the maximum error to 3.33 per cent.

* Allowance for approximation would justify the inclusion of waters containing over 0.36 gm. per liter.

In evaluating the feature in question by this system, it is assigned to the nearest value whether above or below. Thus, weak 4 signifies $4 \times 0.4$ or 1.6 gr. per liter, while medium signifies 2 gr. and medium 2, 4 gr. Hence the range of value of medium 1 is from 1.8 to 3 gr. The term medium is ordinarily omitted and understood to apply when no other strength is indicated. The initial T signifies total mineralization. When no numerical factor follows the descriptive term or symbol, 1 is to be understood. Following are examples of the application of the foregoing procedures. For illustration, both descriptive terms and signs are given:

TOTAL MINERALIZATION.

| Name. | Descriptive symbol. | Interpretation. | | Actual total solids. | |
|---|---|---|---|---|---|
| | | Grams per liter. | Grains per 5 fl. oz. | Grams per liter. | Grains per 5 fl. oz. |
| Buffalo, Va. (Lithia) . . . | Weak 2 or (−T2) | 0.8 | 2 | 0.75 | 1.7 |
| Carlsbad (sprudel) . . . | 3 or (T3) | 6.0 | 15 | 6.61 | 15.0 |
| French Vichy (Grande Grille) | 4 or (T4) | 8.0 | 20 | 7.47 | 17.0 |
| Hathorn (Saratoga, N. Y.) . | Strong or (+T) | 10.0 | 25 | 10.86 | 25.0 |
| Hunyadi (Janos) . . . . | Strong 4 or (+T4) | 40.0 | 100 | 42.27 | 96.0 |
| Mount Clemens (Michigan) . | Very strong 2.6 or (++T2.6) | 130.0 | 325* | 128.65 | 294.0 |
| Pluto (Indiana) . . . . | Very strong 2 or (++T2) | 100.0 | 250* | 98.54 | 225.0 |
| White Rock (Wisconsin) . . | Weak 3 or (−T3) | 1.2 | 3 | 1.20 | 2.8 |

* The use of the exact factor 114 would give 296 and 228, respectively.

In the above table and in what follows values of waters used for illustration are based, in the case of foreign waters, upon well-known analyses, and in the case of domestic waters upon the analyses reported in *Bulletin* 91.[1]

**Scheme for Designating Alkalinity.**—In order to get some notion as to what constitutes an amount of mineral substance that imparts to water a particular medicinal value, suppose we first consider alkalinity or antacid action. In order that a water be classed as *alkaline*, in the medicinal sense, it is not merely necessary that its relative alkalinity be the dominant feature of its mineralization, as in a chemical classification, but that it possess an absolute degree of alkalinity that gives to the water medicinal virtue by reason of that quality. If the alkalinity be expressed in terms of sodium bicarbonate what minimum dosage of such alkalinity must a given amount of the water contain to justify its designation as an alkaline water from the medicinal viewpoint?

By application of the above scheme to designate alkalinity (A) we may consider alkalinity weak that is equivalent to 0.4 gm.† of sodium bicarbonate per liter (1 gr. per 5 fl. oz.); medium, 2 gm. (5 gr. per 5 fl. oz.); strong, 10 gm. (25 gr. per 5 fl. oz.); etc. It is assumed

† In calculating the alkalinity as sodium bicarbonate from the bicarbonic ion ($HCO_3$), the factor 0.3 gives very close approximations to the desired sodium bicarbonate amounts.

that a degree of alkalinity below weak may be disregarded as not possessing medicinal value. By this system French vichy, either Grand Grille or Celestins, is alkaline 3, or (A3) if the abbreviated form of expression is adopted. If it is desired to express both the alkalinity and total mineralization the expression becomes: alkaline, 3T4 or (A3T4). This interpreted means that the water has approximately an alkalinity as sodium bicarbonate equivalent to 2 × 3 or 6 gm. per liter (5 × 3 or 15 gr. per 5 fl. oz.), and total solids to the amount of 2 × 4 or 8 gm. per liter (5 × 4 or 20 gr. per 5 fl. oz.), the accurate figures being 6.52 gm. (14.9 gr.) and 7.47 gm. (17 gr.), respectively.

Two subgroups of medicinal alkaline waters are to be recognized, namely: (*a*) Those in which the alkalinity is due largely to bicarbonates of the alkalies, chiefly sodium; (*b*) those in which the alkalinity is due largely to bicarbonates of the alkali earths, more commonly calcium, frequently calcium and magnesium and occasionally magnesium. Some waters contain notable amounts of both *a* and *b*. If desired, the notation *a*, *b* or *ab* may be added to indicate the kind of alkalinity; also CO for carbonate, Bo for borate and Si for silicate alkalinities which are of relatively infrequent occurrence.

Of some 55 waters, analyses of which are reported in *Bulletin* 91, on the basis of the chemical classification, 21 waters are classed as alkaline. Of these, the following are alkaline on the basis of the above medicinal classification:

| Name. | Description and symbol. |
|---|---|
| Allouez magnesia (Wisconsin) | Weak alkaline b, −T2 or (−Ab, −T2) |
| Golindo lithia (Virginia) | Weak alkaline b, −T2 or (−Ab, −T2) |
| Geyser (Saratoga, N. Y.) | Alkaline a3, T4 or (Aa3, T4) |
| Manitou table (Colorado) | Alkaline ab, T2 or (Aab, T2) |
| Massanetta (Virginia) | Weak alkaline b or (−Ab) |
| Osceola (Virginia) | Weak alkaline (b) or (−Ab) |
| Rubins Healing Springs (Virginia) | Weak alkaline b2 or (−Ab2) |

Where the indication for the total mineralization is not greater than the indication for the special mineralization, as with the last three waters, indication for the total mineralization is omitted.

None of the other 14 waters, which together with the 7 cited make up the 21 classed chemically as alkaline, possesses sufficient alkalinity to be included in the medical classification. On the basis of total mineralization, one of them is weakly mineralized (−T). Its qualifying ingredients leads to its consideration later.

**Scheme for Designating Salinity.**—In presenting the medicinal classification of *saline waters* (Group III), it is well to consider the subgroups separately, since the medicinal actions are not quite the same. In subgroup (*a*) we place the muriated or *chloride salines* (Cl). Common usage and convenience justifies employing the term saline, unqualified, to indicate these chloride salines, adopting appropriate qualifying terms to designate other salines.

If the scheme described for total mineralization and for alkalinity be applied to saline waters, thus indicated, expressing the chlorides

as sodium chloride, there probably will be general agreement that the weak saline concentration will be the minimum quantity entitled to recognition as exercising medicinal action. Moreover, it is probably the lowest concentration that ordinarily need be taken into account when a patient is put on a so-called salt (chloride) free diet. With the saline ingredients of medium concentration, we reach a strength where the repeated ingestion of such a water may, at least on some individuals, have a slight laxative action; while with a strong concentration we have a strength that generally has a laxative action, even when only $\frac{1}{2}$ liter (1 pint) is ingested at one time. This is approximately the strength of physiological salt solution and is the salt concentration of one of America's most noted saline laxative waters, namely Hathorn No. 2 (Saratoga, N. Y.), although the alkalinity of this water puts it in the class of alkaline-saline waters.

Among the noted European saline waters are:

| Name. | Description and symbol. |
|---|---|
| Kissingen (Rakoczy) | Saline 3, +T or (Cl 3, +T) |
| Homberg (Elizabeth) | Strong saline or (+Cl) |

*American Saline Waters in Bulletin* No. 91.

| | |
|---|---|
| Arondack (Saratoga, N. Y.) | Saline T2 or (Cl, T2) |
| Blue Lick (Kentucky) | Saline 4, +T or (Cl 4, +T) |
| Deep Rock (Oswego, N. Y.) | Saline or (Cl) |
| Mount Clemens (Michigan) | Very strong saline 2.6 or (++ Cl 2.6) |
| Star (Saratoga, N. Y.) | Saline or (Cl) |
| Victoria (Saratoga, N. Y.) | Saline or (Cl) |
| Webster (West Virginia) | Saline 3 or (Cl 3) |

The list includes all of the waters designated muriated saline on the basis of the chemical classification, in *Bulletin* No. 91.

By the comparison and interpretation of the above symbols, it is seen that Deep Rock, Star and Victoria waters are of approximately the same saline strength, being one-fifth that of physiological salt solution (5 gr. per 5 fl. oz.); that Arondack is of similar chloride strength but contains somewhat more solids, that Webster is three times and Blue Lick four times the strength of the waters just mentioned, the latter containing appreciable additional solids, while Mount Clemens is somewhere near thirteen times the strength of physiological salt solution.

In subgroup (*b*) of Group III we place the waters in which the *sulphates* are the dominant ingredients. Unqualified, the term sulphate-saline or sulphate has reference to the sulphates of sodium and magnesium. The quantities indicated are the anhydrous salts which make up about one-half the salts with the water of crystallization, and hence are double the strength of the ordinary pharmacy Epsom or Glauber salts. When calcic sulphate is the dominant ingredient the further qualifying designation calcic sulphate-saline or *calcic sulphate* is used. When there are several sulphates present the total sulphates have reference to the sum of the sulphates when the sulphuric ion is distributed according to the scheme of *Bulletin* No. 91. The weak

sulphate waters may be expected to have little more pharmacological action than the stimulating action to the gastro-intestinal mucosa that is the property of saline matter in general together with some diuretic action. The medium concentrations, varying from 1.8 to 9 gm. per liter (4.5 to 22.5 gr. per 5 fl. oz.), especially in the quantities approaching the upper limits, considering their double strength, may exercise a laxative action, more probably with repeated ingestion. The strong concentration may be expected to be frankly laxative. The very strong concentrations include many of the well-known natural cathartic waters.

Examples of the European waters are:

| Name. | Description and symbol. |
|---|---|
| Kissingen Bitter Water | Strong sulphate +T3 or (+S, +T3) |
| Puellna | Strong sulphate 3 or (+S3) |
| Hunyadi Janos | Strong sulphate 4 or (+S4) |

*American Sulphate Waters in Bulletin* No. 91.

| | |
|---|---|
| Bedford (Pennsylvania) | Calcic sulphate or (CaS) |
| Berry Hill dyspepsia | Calcic sulphate or (CaS) |
| Buffalo lithia | Weak calcic sulphate −T2 or (−CaS, −T2) |
| Geneva lithia | Calcic sulphate or (CaS) |
| Pluto concentrated | Very strong sulphate 2 or (+ +S2) |
| Tate Epsom | Calcic sulphate or (CaS) |
| Veronica | Strong sulphate 1.6, +T2.3 or (+S1.6, +T2.3) |

The list includes all of the waters designated sulphated on the basis of the chemical classification in *Bulletin* No. 91. By the interpretation made possible by the scheme employed the relative and approximate absolute sulphate strengths are readily appreciated.

Subgroup (*c*), Group III, comprises medicinal mineral waters in which saline *phosphates* are the dominant pharmacological ingredients. For the purpose of illustrating the application of the present scheme, it does not matter whether or not the single example of such a water in *Bulletin* No. 91 is a natural or artificial mineral water. Expressing the phosphate in terms of disodium phosphate, we have Red Raven aperient (Pa); strong phosphate 2.6 or (+P2.6). The interpretation is apparent. It may be questioned whether the water should not be classified as alkaline phosphate and the relative strength of each of these qualities expressed, but since disodium phosphate is a known alkali, it need not now be attempted.

Subgroup (*d*), Group III, includes saline *nitrates*. There is a single example of such a water in *Bulletin* No. 91. The strength as sodium nitrate and magnesium nitrate total 0.189 gm. per liter. We do not know at this time that this imparts any medicinal quality. When it is known that nitrates in waters are of medicinal value the classification on the basis of the scheme already set forth may be made. The total mineralization does not bring it into the class of medicinal waters, as described above.

**Scheme for Expressing Qualities of Alkaline-saline Waters.**—Group II, alkaline-saline waters, comprises those waters that combine the qualities of Groups I and III. The degree of alkalinity and the saline quality and quantity as affecting the medicinal values are conveniently expressed by combining the indications of the individual features as set forth for the previous separate groups. Thus, Congress water (Saratoga, N. Y.) is both alkaline b2 and saline 3. Hence, its medicinal classification is: alkaline b2, saline 3 or (Ab2, Cl 3), meaning that approximately it has an alkalinity equivalent to 4 gm. of sodium bicarbonate per liter and is saline with chlorides equivalent to 6 gm. of sodium chloride per liter.

In thus combining these qualities there is another factor that must be considered. For example, weak alkaline imparts medicinal qualities to a water only when the water is taken in large quantity and possibly in repeated doses. Therefore, it must be considered whether the associated saline mineralization permits or makes desirable the ingestion of such large quantities or repeated doses of the water. If it does then the alkalinity may exercise its medicinal quality, but if the saline ingredients are of such a strength that only a lesser quantity and a single dose may be administered then the amount of alkalinity of the water so administered must determine its medicinal value as an antacid.

In the case of Congress water, cited above, a single moderate glass (150 cc. or 5 oz) may be considered sufficient to have a medicinal effect. Such an amount is calculated from its descriptive symbol to contain 0.6 gm. (10 gr.) of calcium-magnesium alkalinity (in terms of sodium bicarbonate) and 0.9 gm. (15 gr.) of chlorides, as sodium chloride. Hence it may be concluded that the alkalinity as well as the chlorides contributes to the medicinal action of this water and hence that medically it is an alkaline-saline water. In all probability the alkali not only contributes its antacid quality to the water, but, as well, enhances the action of the water as a saline, so that its total mineralization, strong, or (+T), *i. e.*, 10 gm. per liter (25 gr. per 5 fl. oz.), will measure its value as a medicinal mineral water, its action being that of a saline of that strength, rather than Cl 3, with the added antacid feature. In this water the antacid constituents, as sodium bicarbonate, constitute two-fifths of the total mineralization.

Looking at the alkaline-saline water Selters (Hesse-Nassau), perhaps the oldest and best known of all waters, it has a strength represented by weak alkaline a3, saline, or (−Aa3, Cl, T2), in which the alkalinity similarly makes up three-tenths of the total mineralization. A fair rule to follow for medicinal waters is that if the alkalinity, as sodium bicarbonate, constitutes as much as two-thirds of the total mineralization, such a water is to be regarded as an alkaline water, while if it constitutes less than two-thirds, but as much as one-quarter, then it constitutes an alkaline water compounded with the particular mineralization that dominates the remaining mineral solids. Both

the above examples fall into the subgroup (*a*) in which the saline consists of chlorides.

Following are American alkaline-saline (Cl) waters of this subgroup:

| Name. | Description and symbol. |
|---|---|
| Carlsbad | Alkaline ab3, saline 4 or (Aab3, Cl 4) |
| Champion | Alkaline b, saline 2 or (Ab, Cl 2) |
| Chief | Alkaline ab3, saline 2 or (Aab3, Cl 2) |
| Congress | Alkaline b2, saline 3 or (Ab2, Cl 3) |
| Hathorn | Alkaline b2, saline 3 or (Ab2, Cl 3) |
| High Rock | Weak alkaline b4, weak saline 2 or ( −Ab4, −Cl 2) |
| Lincoln | Alkaline b3, saline 3 or (Ab3, Cl 3) |
| Magnetic | Alkaline b, saline or (Ab, Cl) |
| Peerless | Alkaline ab2, saline or (Aab2, Cl) |
| Seltzer | Weak alkaline b4, weak saline 4 or ( −Ab4, −Cl 4) |
| Vichy | Weak alkaline a2, weak saline 4 or ( −Aa2, −Cl 4) |
| White Rock (Wisconsin) | Weak alkaline b, weak saline 2 or ( −Ab, −Cl 2) |

All, excepting the last, are from the Saratoga, N. Y. Springs. The list includes all but the Sheboygan water designated alkaline-saline waters in *Bulletin* No. 91 on the basis of the chemical classification, and fall into this group as medicinally alkaline-saline in conformity with the standard just indicated, as do the following additional foreign alkaline-saline waters:

| Name. | Description and symbol. |
|---|---|
| Ems (Krauchen) | Alkaline a, weak saline 3 or (Aa, −Cl 3) |
| Gleichenberg (Constantin) | Alkaline ab3, saline or (Aab3, Cl) |

If the saline matter consists of sulphates either in whole or in part, that fact can be indicated, as is apparent from the following:

*Foreign Waters.*

| Name. | Description and symbol. |
|---|---|
| Carlsbad (Sprudel) | Alkaline, weak saline 3, sulphate or (Aa, −Cl 3, S) |
| Marienbad (Kreuz) | Alkaline 2, weak saline 4, sulphate 3 or (Aa2, −Cl 4, S3) |

There is a single example of an American water of this type in *Bulletin* No. 91:

Sheboygan (Wisconsin) . . Weak alkaline b2, saline, weak sulphate 2 or ( −Ab2, Cl, −S2)

The interpretation of this expression is:

| | Grams per liter. | Grains per 5 fl. oz. |
|---|---|---|
| Alkalinity, alkali earth, equivalent of sodium bicarbonate | 0.8 | 2 |
| Salines: | | |
| Chlorides, as NaCl | 2.0 | 5 |
| Sulphates, sodium and magnesium | 0.8 | 2 |

The accurate figures for grams per liter are 0.88, 2 and 0.65 respectively, with a total mineralization of 3.6.

Subgroups (*c*), alkaline phosphates, and (*d*), alkaline nitrates, follow the same rule for their symbols, but are of such exceptional occurrence that they need not be further described.

**Evaluation of the Medicinal Properties of Calcium in Waters.**—In what has gone before no effort has been made to evaluate mineral waters on the basis of *calcium* present. Without particular knowledge on the subject, the conclusion would seem justified that calcium is so widely distributed in Nature that the amount in water would not meet any actual requirement of the body and, hence, would be superfluous. It happens, however, that special studies[2] have shown: (1) That calcium constitutes a larger proportion of the body weight than does any other of the "inorganic" elements; (2) that it is very irregularly distributed among the staple articles of food, many of which are extremely poor in calcium; (3) that the "ordinary mixed diet" of Americans and Europeans, at least among dwellers in cities and towns, is probably more often deficient in calcium than in any other element; (4) that the food should furnish at least 0.67 gm. of calcium (as Ca) per adult per day; (5) that the requirement of the growing child is even greater in proportion to body weight; (6) that about 50 per cent of the American dietaries so far studied show less than this amount; (7) that the inorganic forms of calcium, such as occur in mineral waters, are utilized in nutrition.

Hence, it may well be that in many instances the calcium of mineral waters is of a degree of importance to the consumer that is not generally recognized. Especially would this seem to be true of chronic invalids, bedridden patients and others when they are consuming less than the ordinary amount of food; of women during pregnancy, when the calcium requirements are greatly increased; of individuals with excessive oxalate formation in the body, since the elimination of oxalate is largely if not wholly as the oxalate of calcium, a condition which the writer finds much more frequent than is ordinarily recognized.

Since calcium ordinarily occurs in mineral waters either as the bicarbonate or as the sulphate, and since the alkalinity of the alkali earths (*b*) and the predominance of calcium sulphate are indicated in the scheme set forth, there is some basis for judgment as to the amount of calcium present even without a specific evaluation. When the importance of the calcium is further established it may be desirable to incorporate in the symbol of the medicinal classification a more exact evaluation of this element.

The amount of calcium bicarbonate multipled by 0.25 and the amount of calcium sulphate multiplied by 0.29 give the corresponding amounts of calcium contained in these compounds. Hence, to supply in 1 liter of water the total amount of calcium desirable for an adult requires a calcium-bicarbonate alkalinity expressed as sodium bicarbonate of about 2.8 gms. per liter or medium 1.4, or a calcium sulphate concentration of 2.3 gms. per liter or slightly more than medium 1. It is hardly to be supposed, however, that any individual would be required to derive his entire supply of calcium from his mineral-water supply. If, as seems probable, it is of value it is in the great majority of instances because it makes up a greater or less deficiency existing in the diet of the individual.

**Symbols Expressing Degree of Acidity in Acid Waters.**—Group IV are acidic waters. The two examples in *Bulletin* No. 91 are waters in which the acid is *aluminum sulphate*. In this substance the aluminum is such a weak cation that the anion asserts its acidic property, as indicated by the following reaction:

$$\underset{342}{Al_2(SO_4)_3} + \underset{504}{6NaHCO_3} \rightarrow 2Al(OH)_3 + 3Na_2SO_4 + 6CO_2.$$

Hence 1 part of aluminum sulphate is capable of neutralizing 1.47 parts of sodium bicarbonate. It is advantageous to express the acidity in terms of the quantity of sodium bicarbonate the acid can neutralize, for by so doing the quantity of acidity and alkalinity can be directly compared. In Rockbridge alum water (Virginia) there is 0.337 gm. aluminum sulphate per liter, capable of reacting with $0.337 \times 1.47$, that is 0.595 gm. of sodium bicarbonate. Hence, in terms of sodium bicarbonate neutralizing capacity the water is a weak acid, or (−AcAl 1.5), employing the decimal because of the desirability of giving a close approximation to a water of this character. The remaining mineralization of this water is slight and negligible. The other water of Group IV in *Bulletin* No. 91 is Wallawhatoola (Virginia). Its 0.287 gm. aluminum sulphate is capable of neutralizing 0.42 gm. of sodium bicarbonate. Hence, the concentration is expressed by weak acid or −AcAl. The remaining mineralization of this, as with the other so-called alum water, is likewise slight and negligible. We are certainly justified in believing that these waters fall into the medicinal class because of their distinct acidity and, as well, because of their slight astringent action.

Acid waters in thich there is *free sulphuric acid* occur in a few springs in this country. Free sulphuric acid ($H_2SO_4$) may be expressed in terms of sodium bicarbonate equivalent by multiplying the amount by the factor 1.69; acid-sodium sulphate by the factor 0.7; acid-potassium sulphate by the factor 0.62. A weak acid water, that is, one with the acidity of 0.4 gm. per liter, expressed in terms of sodium bicarbonate equivalent, would have an acidity a little less than one-tenth the usual acidity of gastric juice ($0.4 \times 0.4 = 0.16$ gm. HCl per liter). It seems reasonable that this degree of acidity, and possibly with some individuals even less, may exert an effect by modifying the secretions of the mouth and stomach.

**Scheme for Expressing Degree of Mineralization in Ferruginous Waters.***—Group V, the *iron* or *chalybeate* waters, depend for their special medical quality upon iron, usually accompanied by manganese and sometimes by notable quantities of aluminum. In some waters these occur as bicarbonates and seem to exert their beneficient effects by lessening hypersecretion, either gastric, intestinal or both. Whether they increase the iron of the blood and supply iron to the cells of the body generally, as is quite commonly held, is not clear. Schwalbach

* Iron is evaluated in terms of ferrous bicarbonate.

(Strahl Springs) is one of the oldest of the European waters of this type, and contains 0.114 gm. per liter of these metals, chiefly iron as bicarbonates. This does not bring it into the class of weak concentration, but recognizing the class one-fifth the strength, very weak, the water is very weak ferruginous. It will be granted, I take it, that these heavy metals exert a medicinal action in considerably less concentration than the mineralization previously considered. There are also present in Schwalbach water alkali-earth bicarbonates, so as to render it weak alkaline, so that the full classification is very weak ferruginous, weak alkaline or (− −Fe, − Ab).

Pyrmont (New Spring) is another famous European chalybeate water. The combined manganese and iron bicarbonates are 0.214 gm. per liter, of which manganese comprises over two-thirds. Hence, it is very weak mangano-ferruginous 3, weak alkaline b4, weak saline 3, weak sulphate 2 or (− −Mn Fe3, −Ab4, −Cl 3, −S2). The interpretation of this symbol—manganese and iron bicarbonates, 0.24 gm.; alkali-earth alkalinity, 1.6 gm.; chlorides, 1.2 gm.; sulphates, 0.8 gm. per liter—gives an approximate and adequate idea of the composition of the water as a medicinal agent.

In *Bulletin* No. 91 of the waters described only one is designated ferruginous, namely Mardela (Maryland), which contains iron equivalent to 0.043 gm. ferrous bicarbonate, not much over one-half the amount that would bring it medicinally into the group under consideration. However, there is also present aluminum in amount equivalent to 0.032 gm. aluminum sulphate, which as a local agent certainly has much of the qualities of iron, so that we are quite justified in designating: Mardela (Maryland), very weak, aluminic-ferruginous or (−A1Fe). The water is designated ferruginous-alkaline in *Bulletin* No. 91, but the alkalinity is far too weak to regard it as contributing any medicinal quality to the water.

It is important to determine whether the *qualifying ingredients* of the chemical classification contribute medicinal qualities to natural waters, and, if so, to what extent? To this end, they will be considered individually.

**The Lithium Content of Mineral Waters.**—The term *lithic* or lithia waters has been applied to a considerable number of waters containing relatively small amounts or even only traces of salts of lithium.[3] The particular medicinal virtue claimed, by reason of the presence of this alkali-metal, has been that it forms soluble lithium urates in the body and thus removes the urates from the body. This notion of the medical profession has now been disproved, so that any claims of medicinal value because of the presence of lithium in any amount in which it occurs in natural waters is no longer tenable. However, it is fair to state that the responsibility for the former views, now known to be erroneous, rests primarily with the medical profession, though it must be stated with equal frankness that chemists have failed to exercise reasonable discretion in pronouncing waters lithic

and the proprietors of such waters in representing their product on the basis of such pronouncements. In some cases at least the error has been in not assigning qualities that actually exist to the correct mineralization rather than in making claims of qualities that were not in some measure justified.

The qualifying term lithic, then, may be used to indicate the presence of lithium in an amount that is always very small, but it no longer finds a place in designating medicinal values of such waters by reason of the presence of such lithium.

**The Bromic Content of Mineral Waters.**—*Bromine*, as bromide, is not infrequently present in mineral waters, always in very small amount. The amounts as potassium bromide, recognized to qualify waters as bromic in the Chemical Classification of *Bulletin* No. 91, in 17 waters range from 0.01 to 0.487 gm. per liter ($\frac{1}{5}\frac{1}{0}$ to 1 gr. per 5 fl. oz.). Since the bromide is always accompanied by very much larger quantities of saline (chlorides), and taking into consideration the total mineralization and, by reason thereof the amount of water that will or can be ingested, the question arises whether the bromide may be ingested in sufficient dosage to have any therapeutic effect. If ingested in repeated doses of 5 fl. oz., a water containing 0.4 gm. per liter, or approximately 1 gr. in 5 fl. oz., might with some degree of reason be thought to exercise some slight action in the body, but it happens that this particular water contains some 125 gm. per liter (300 gr. per 5 fl. oz.) of mixed chlorides, and repeated doses cannot be taken. The proportion of bromide to total mineralization in the various waters varies from 0.25 to 1.5 per cent, averaging under 0.5 per cent, which means that to obtain a single grain of bromide in the water containing the maximum proportion some 2 quarts of water would be required, repeated dosage of which is obviously out of question. Every consideration then limits the term bromic to its chemical meaning and gives no reason for recognizing bromic as indicating medicinal qualities.

**The Evaluation of the Iodine Content of Mineral Waters.**—*Iodine*, as iodide, occurs in 8 of the 55 waters of *Bulletin* No. 91 in sufficient amount to justify the authors calling such water "iodic," in the chemical sense. The amount present expressed as iodine is 1 or 2 parts per 1,000,000, or milligrams per liter ($\frac{1}{4}\frac{1}{4}\frac{1}{0}$ to $\frac{1}{2}\frac{1}{2}\frac{1}{0}$ gr. per 5 fl. oz.). This amount is certainly small.

It happens, however, that iodine in very small amount is essential to the human body, that lack of it is an important factor in causing endemic goiter,[4] and that endemic goiter is prevented by the ingestion during each week of very small amounts, such as 5 mg. ($\frac{1}{1}\frac{1}{3}$ gr.). It follows, then, that the ingestion of 17 to 34 drinks per week of 5 fl. oz. of the "iodic" waters would ordinarily supply sufficient iodine to the body to prevent the development of simple goiter. Under these circumstances, if the ingestion of this quantity or a substantial portion of it is not rendered impracticable by the character and amount

of the other mineralization, the water must be recognized as prophylactic, and for that purpose and to that extent regarded as medicinal.

Of the 8 "iodic" waters of *Bulletin* No. 91 the mineralization of 1 is very strong; of 5, strong; of 2, medium. With the exception of the first, which is very strong, it is quite within reason that these waters might be administered at least for a time in the dosage required to carry the amounts of iodine indicated as prophylactic for simple goiter. Further, it is entirely reasonable that in a region where simple goiter is endemic the physician ordering alkaline-saline waters would wish to give preference to these "iodic" waters. It is therefore correct and helpful that they should be regarded as medicinally "iodic" in this prophylactic sense. For the treatment of an already existing simple goiter, the dosage they carry would hardly be considered adequate, while for iodide treatment of many conditions they would be practically wholly inadequate. The waters which in this sense may be qualified as medicinally iodic are the Saratoga, N. Y., waters: Carlsbad, Chief, Congress, Geyser, Hathorn, Lincoln and Peerless.

**The Arsenical Content of Mineral Waters.**—*Arsenic* is detected in mineral waters relatively infrequently. Two such are reported in *Bulletin* No. 91, one containing a trace, the other 0.32 parts per 1,000,000, as disodium arsenate. There is, perhaps, some possibility that these minute amounts have a value to the body and even may supply an arsenic deficiency. This fact cannot be considered as established nor is it absolutely disproven. Pending further light upon these questions, in considering the amounts here present it seems necessary to regard the qualifying declaration "arsenic" as indicating the unusual presence of the element rather than denoting a quality of known medicinal value, even in the prophylactic sense. One of the waters in question is not mineralized, as defined in the above medicinal classification, and the other has only a weak mineralization (—T); hence, in so far as the total mineralization is concerned, they may be drunk freely.

**The Aluminic Content of Mineral Water.**—*Aluminum*, when present in dominant amounts, has already been considered. There is some question whether it is not an essential constituent of the body,[5] but, even so, it is so widely distributed that its presence in mineral water in very small amounts can hardly be regarded as imparting medicinal value to the water. As already suggested, in chalybeate waters it possibly adds to the local action of the iron and in that connection may be given consideration.

**The Manganese Content of Mineral Waters.**—*Manganese* in all probability acts locally, as does iron, and as already stated is to be given weight in evaluating chalybeate waters.

**The Silica Content of Mineral Waters.**—It is possible that *silica* is an essential ingredient of the body. However, its wide distribution eliminates mineral waters as a valuable source of this element. Its particular value is the extent to which the silicates contribute to the alkalinity, which is usually slight.

**The Gases in Mineral Waters and Their Therapeutic Importance.**—*Gases*, dissolved in water, when present in quantity doubtless contribute definitely to the medicinal value. Probably beyond question, in cases where indicated waters charged with carbon dioxide are enhanced medicinally because of this condition; likewise, with sulphuretted waters. In the case of *carbon dioxide*, if the water is insufficiently charged with gas to be apparent, it is a still water and any gas present may be ignored as a medicinal quality. As a tentative rule, the writer adopts the standard, apparently used in *Bulletin* No. 91, of classifying waters as carbon-dioxated when they contain a minimum of 100 cc. of free carbon dioxide per liter.

With *hydrogen sulphide* the case is different, since it reveals its presence by the odor it imparts to the water, and hence, at least with some individuals, is capable of exerting a physiological effect, possibly largely a mental reaction. So truly is this so, that with certain individuals, even a small amount reacts unfavorably and hence is undesirable. For these reasons in the medicinal classification a sulphuretted water should be so indicated. As a tentative standard the writer applies the designation to all waters containing 2 cc. per liter of the gas.

**Radio-activity of Water.**—Radio-activity of water is ordinarily due to the solution of radium emanations which in the course of a few days are dissipated. In such instances, this quality is available only when the water is drunk or used as a bath at its source or at most not removed in time more than one or two days. Infrequently, waters contain the radium element, so that with dissipation new emanations are evolved, thus tending to maintain an equilibrium of radio-activity, even when removed from their source. As commonly employed, the term radio-activity of mineral waters has reference only to the presence of the emanations. When radium salts are present the fact should be specifically indicated.

**Standards for Expressing Degree of Radio-activity of Mineral Waters.**—For stating the radium emanations in water two systems of units are in vogue, the one employing the microcurie (mc), the other the Mache (Mu). The microcurie is accurately defined as the maximum emanation from 0.001 mg. of radium. It is generally considered that 2700 Mache units are the equivalent of 1 mc. On this basis, 1 Mache unit is the equivalent of 0.00037 mc. or 0.37 millemicrocurie. The concentration indicated is the number of units per liter of water.

The therapeutic value of radium emanations seems established. As to what constitutes a required dosage, the Council on Pharmacy and Chemistry of the American Medical Association do not accept[6] any radium emanation generator which yields less than 2 mc. of emanations per twenty-four hours, this being the minimum dosage which they recognize. This dosage is much in excess of the amount of radio-activity of natural waters. Hence, the standards here tentatively adopted are a measure of the relative occurrence of radium emanations

in natural waters rather than an expression of the therapeutic values of such amounts, leaving conclusions as to the latter for more mature experience in their use. On the basis of present experience there is reason for believing that doses considerable below 2 mc. in twenty-four hours have some though perhaps not specific remedial values. Since the Mache unit is the unit almost universally used to measure the radium emanations in American waters, the following terms for radio-activity are employed:

Up to 2 Mu., very weak radio-activity.
Up to 10 Mu., weak radio-activity.
Up to 50 Mu., medium radio-activity.
Up to 250 Mu., strong radio-activity.
Over 250 Mu., very strong radio-activity.

The employment of multiple factors, as with the terms expressive of other qualities of waters outlined in the foregoing pages, makes possible close approximations of the actual values.

The following amounts of radium eminations, expressed as Mache units per liter, have been reported.[7] Except as indicated,* values are obtained by multiplying millemicrocuries by 2.7.

FOREIGN WATERS.

| | |
|---|---|
| Mine water, St. Joachimsthal, 500 m depth, Czecho-Slovakia | 442 |
| Choussy, La Bourboule, France | 436 |
| Vanquelin, Plombières, France | 233 |
| Bordeu (Grande Source) Luchon, France | 364 |
| La Chaldette, France | 253 |
| Providence, Vernet-les Bains, France | 313 |
| Büttquella, Baden-Baden, Schwarzwald Region, Germany | 139 |
| Wettingquella, Brambach, Saxony, Germany | 2231 |
| Trinkquella, Oberschlema, Saxony, Germany | 1858–2484 |
| Old Roman Spring, Lacco Ameno, Ischia, Italy | 372* |
| Tandberg estate, Simoa Vally, Norway | 182 |
| Hot spring, Koria District, Bombay, India | 89– 168 |
| Kamigawara, No. 1, Masutomi, Japan | 813 |
| Ena-Kosen, Takayama, Japan | 276 |
| Louise, A. Hammam Bon Hadjar, Algeria | 60 |

UNITED STATES WATERS.

| | |
|---|---|
| Dixon Spring, No. 2, Illinois | 7.9 |
| Hot River, Mammoth Hot Springs, Yellowstone National Park | 3.9 |
| Imperial Spring, Hot Springs, Arkansas | 24.4 |
| Kidney Spring, Hot Springs, Arkansas | 9.8 |
| Shoshone Spring, Manitou, Colorado | 9.1 |

**The Advantages of the Medicinal Classification of Mineral Waters.**—In the foregoing scheme it will be noted that, as a rule, the medicinal values of the mineral ingredients of waters begin with the indicated standard weak concentration. Exceptions to this are iron and possible acidity which are regarded as slightly medicinal in the standard very weak concentration and iodine, of prophylactic value in amount as low as 1 part per 1,000,000. For pronounced medicinal action it is important in the case of some ingredients that the concentration be medium or even strong. For example, weak concentrations of sodium

and magnesium sulphate cannot be expected to exert any laxative action, though they may be slightly stimulating to the gastro-intestinal mucosa and perhaps, when absorbed, to the renal function, and in this way in weak concentration are of slight medicinal value. In other words, regulation of dosage is required in the selection of mineral waters much the same as in the ordering of drugs by prescription.

It is appreciated, too, that the scheme is altogether too elaborate for the casual reader. However, it presents the following advantages:

1. It standardizes the use of the terms very weak, weak, medium, strong and very strong by giving to them definite meanings, so that even the reader who does not attempt to familiarize himself with the scheme will have definite relative meanings conveyed to him by these terms.

2. It gives the reader who has something more than a casual interest in the subject a system by which, so far as his interest leads him to do so, he can obtain from a relatively simple and condensed formula more definite information than is usually conveyed to such an individual by the analysis alone. To the really serious reader, who takes the trouble to familiarize himself with the scheme, it conveys information of a considerable degree of exactness, quite enough to enable him to evaluate the mineralization without consulting the analysis.

3. It affords a method of tabulating waters in a small space so that their classification will be apparent without the pages of matter required for reporting the analyses in detail. This has the further advantage of ready comparisons of the waters that are thus brought together in a single table.

4. Finally, and by no means least advantageous, it gives a method of medicinal evaluation to the chemist, applicable to his analytical results.

It is with these advantages in mind that the scheme has been developed, as presented.

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## CHAPTER V.

# THE COMMON SOLID INGREDIENTS OF MINERAL WATERS.

By E. H. S. BAILEY, Ph.B., Ph.D.

### THE SOURCE OF MINERAL WATERS.

The sun as he daily visits the earth, one continent after another, is in reality the dynamic force to which we owe our mineral waters. The air, heated by his rays, has a greater capacity for the absorption of moisture than has the cold air, and so from the ocean, the lakes and the rivers and the surface of the earth itself, the moisture is drawn up into the higher regions of the atmosphere. There, as it is condensed by the cooler currents of the air, it floats in feathery clouds, or, with a little lower temperature, it descends again upon the earth in the form of rain.

**The Composition of Rain Water.**—We speak of rain water as pure, and so it is comparatively, but an important property of water is that it absorbs gases readily, and so the water takes up some of the oxygen, nitrogen and carbon dioxide which are always present in the air. This latter gas is normally found in the air in the proportion of 3 parts in 10,000 of air, and is so soluble in water that rain as it descends and washes out the atmosphere often contains fifty times as much carbon dioxide as the same volume of air would contain. There is also ammonia and other nitrogen compounds in the air and in some localities, hydrogen sulphide and sulphur dioxide. The nitrogen content of the rain is about twice that of snow on account of the solvent action of rain. A large part of the nitrogen products present in mineral waters found their way originally from the air washed out by the rain. This then is the rain water that strikes the rocks and soil of the planet, and is the principal tool which Nature uses for the disintegration, reformation and reconstruction of the surface.

*Erosion*, the geologist will tell you, is the great force which has had so much to do with transforming the surface of the earth, so that it has become a fit place for the habitation of the flora and fauna that make it their home. It has cut out mighty valleys, scoured away mountain ranges, covered the plains with fertile soil and built the shore line of the continents far out into the sea. Just as by the process of levigation the artisan reduces his materials to an impalpable powder, so the rocks, sand and gravel have been ground together, as streams carried them down the mountain side, and as the particles were increased so that solvents could act upon them more readily.

**The Soluble Action of Water.**—Water then not only redistributes the loose material on the surface of the earth, but it immediately begins to attack and dissolve everything that is soluble. Some of the water sinks deep into the ground and reappears as springs or in wells, containing more or less mineral matter; some runs off directly into the streams; another part stays in the soil as ground-water, which, when near the surface, is again evaporated into the atmosphere. It has been estimated that about one-fifth of the water that falls on the land of the globe drains off into the rivers, and this carries annually in solution 2,735,000,000 tons of foreign matter to the sea.[3] This is what solution has wrought.

**Ocean Water, Composition and Chemical Action.**—Very little of this immense amount of material carried to the ocean is ever returned to the land. It is true that storms, sweeping inland from the sea carry minute particles of salt with the moisture blown ashore, as the analysis of the soil at different distances from the coast has shown, but most of the mineral salts carried down by the streams are a permanent addition to the salinity of the ocean.

We do not know what was the composition of the primordial ocean, as such a variety of conditions were possible, that might have changed its composition. At present the ocean contains all the ingredients of all mineral springs, and has a salinity of about 3.5 per cent, and more than three-quarters of this material is common salt (sodium chloride). Theoretically, of course, all the mineral substances that exist on the earth are to be found in the ocean water, but the list of those that are present in sufficient quantity to be called appreciable is small.

**Bases and Acids Present in Mineral Waters.**—Returning again to a discussion of the rain water, How does it carry on the process of disintegration of the surface of the earth? Among the agencies mentioned by Geike[4] are: (*a*) Oxidation, which on account of the oxygen dissolved in the water, among other things, changes the sulphides to sulphates, setting free sulphuric acid, which readily unites with carbonates to form salts; (*b*) de-oxidation, as when organic and vegetable matter reduce sulphates to sulphides; (*c*) simple solution, as in the case of common salt or gypsum; (*d*) the formation of carbonates, as in the decomposition of feldspar which yields up its lime or alkalies to percolating water; (*e*) hydration, as when a mineral-like anhydrite takes up water and forms gypsum. The water is often assisted in this process by disintegration of the rocks by freezing and thawing of the material, and in volcanic regions by the high temperature of the water, as the warm water is a better solvent than the cold. Solfataras, geysers and hot springs are examples of the solvent action of hot water. In artesian wells and geysers the water, being under pressure, is a better solvent of mineral material than when acting simply at ordinary atmospheric pressure.

**How Minerals are Dissolved Out of Stone.**—Although we admit that "continued dropping will wear away a stone," yet it is difficult to realize that much of this wearing away is really the soluble action of water and important chemical changes taking place at the same time. As an illustration,[5] take the case of a granite in which the more soluble minerals are first dissolved with the liberation of colloid silica, and at the same time carbonates of lime, magnesia, iron and the alkalies are formed. The other materials are washed away with most of the colloid silica. A later phase of the process is represented by the hydration of the undissolved residues, the feldspars are transformed into kaolin, the magnesian minerals into talc and serpentine and the iron becomes mostly limonite. If quartz is present in the rock mixture it is but little changed. The decomposed rock is later carried down by the streams and distributed in different layers or strata according to its specific gravity.

In considering the common solid ingredients of mineral waters, we are immediately brought face to face with the modern ionic theories. The physiological action of these ions is more fully discussed in Chapter VIII. For convenience we may classify waters as in Chapter IV. A common procedure is to study the "salts" as they are called, or the combination of bases and acids. In this scheme of combination the acids, sulphuric, carbonic, hydrochloric, silicic, boric and phosphoric, are discussed as though actually combined, as is the case in minerals and salts, with the bases, sodium, potassium, lithium, calcium, magnesium, iron, aluminum, etc.

**Carbonated or Bicarbonated Alkaline Waters.**—This is one of the great classes, probably the most important class of waters, for as previously stated the carbon dioxide of the air and of the water has been an important agent in breaking down the rock structure and preparing the different mineral elements for going into solution.

S. Tillman and Heublin[6] have recently stated that a soft water containing free carbon dioxide attacks calcium carbonate much more vigorously than a hard water with the same amount of carbon dioxide, for the reason that a chemical equilibrium exists between calcium carbonate and carbon dioxide on one hand and $CaH(CO_3)_2$ and free carbon dioxide on the other. It is easy to find that part of $CO_2$ which attacks the $CaCO_3$, once the bound and free $CO_2$ have been determined, on the basis of figures obtained by the authors. These waters fall into two classes, in one of which sodium is the principal base or positive ion and in the other the calcium ion is most abundant.

According to Haywood[7] alkaline waters are: (*a*) Those which have an alkaline reaction, and contain carbonic and bicarbonic ions in predominating quantities; (*b*) those which have an alkaline reaction and contain boric or silicic-acid ions in predominating quantities, where it can be demonstrated that the alkalinity is largely due to the presence of borates or silicates. According to a recent definition[8]

saline waters are those which contain carbonic-acid salts either in the presence or absence of free carbon dioxide. Only those salts (and not neutral salts) have any influence on the reaction. Alkalinity should be expressed in terms of hydrogen-ion concentration. Sodium carbonate and bicarbonate waters are strongly alkaline, as they seem to partake more strongly of alkaline qualities than of the acid qualities of the carbonic ion. Carbonic acid is one of the weakest of the acids. These waters are derived from the decomposition of rocks and soil containing considerable sodium in contact with carbon dioxide, often under great pressure. In the latter case the waters are effervescent and so, on exposure at the surface, the excess of carbon dioxide escapes into the air. In general, it may be stated that all waters carrying these carbonates, or, more properly speaking, bicarbonates in considerable quantities, have an alkaline effect when taken into the system.

**Potassium Carbonate and Bicarbonate.**—Potassium carbonate and bicarbonate are formed from the decomposition of rocks and soil in the same way and under similar conditions to the formation of the corresponding sodium salts. As an illustration of this fact the experiments of A. Daubree[8] are illuminating. He agitated 3 kg. of orthoclase with pure water for one hundred and ninety-two hours in a revolving iron cylinder, and the solution contained 2.52 gm. of $K_2O$ with trifling amounts of silica and alumina. Two kilograms of feldspar, shaken for ten days in water saturated with carbon dioxide, gave 0.27 gm. of $K_2O$ with 0.75 gm. of silica.

**Calcium Carbonate and Bicarbonate.**—Calcium carbonate and bicarbonate, often associated with the corresponding magnesium salts, are very common constituents of mineral waters, and, in fact, of most potable waters. When water, charged with carbon dioxide, either under rock pressure, or at the ordinary atmosphere pressure, comes in contact with the carbonate of calcium or magnesium in the rocks, in which there is usually an excess of carbon dioxide present, the lime and magnesia are dissolved in accordance with the reaction:[9] $CaCO_3 + H_2O + CO_2 = CaH_2(CO_3)_2$, which is known as calcium bicarbonate and is more soluble in water than the carbonate. This is the form in which the lime is carried away in the streams. If, however, the temperature of the water is considerably raised, or the water is allowed to evaporate spontaneously, as from the roof of a cave, the excess of carbonic-acid gas leaves the water, and the mineral, calcium carbonate, is again deposited in accordance with the reaction: $CaH_2(CO_3)_2 = CaCO_3 + CO_2 + H_2O$. Waters of this class have a neutral and often an alkaline reaction, as they frequently contain an excess of sodium carbonate.

Calcium and carbon dioxide are the chief additions made to the water of the ocean by the rivers, and they are the substances most ordinarily withdrawn from the ocean water by living organisms. When thus removed they form calcium carbonate which is the principal

substance in corals and shells. Although the living animal secretes the amorphous carbonate, after a time when it becomes a part of a rock it is partially changed to a crystalline carbonate which is less soluble than the amorphous form.[10] These facts have a bearing on mineral waters, because the rocks once formed beneath the ocean, after long geological ages, have become a part of the land, and are in turn again subjected to the action of fresh water. Calcium is found in practically all the rocks, in greater or less quantities, and is, in fact, next to aluminum, the most abundant metallic element in the earth's crust.

**Magnesium Carbonate and Bicarbonate.**—Magnesium carbonate and bicarbonate are also very common constituents of waters and are usually associated with the calcium salts. This element in waters may occasionally be derived from the decomposition of igneous rocks, but comes more abundantly from such common silicates as talc, serpentine and chlorite and also from magnesite and dolomite. In general, it may be stated that magnesium bicarbonate finds its way into water in the same way that calcium bicarbonate is dissolved, *i. e.*, by solution in the presence of an excess of carbon-dioxide gas. The mineral magnesium carbonate is deposited in the same way when there is an opportunity for the water to evaporate. On account of its therapeutic action magnesium is considered of more importance in mineral waters than calcium.

**Ferrous Bicarbonate.**—Iron in the form of ferrous bicarbonate is often present in the so-called bicarbonate waters. We consider its formula to be $Fe(HCO_3)_2$, although it is very readily decomposed when in contact with the air. Deposits of laterite, from the breaking down of the earlier rocks or as gossan caps over bodies of sulphide ores are formed according to F. W. Clarke.[11] The outcrops of such ores, especially a pyrite of chalcopyrite, are altered to masses of porous limonite, a hydrated ferric oxide. In the oxidation of these sulphides a part of the iron is carried off in solution as ferrous sulphate, from which it may later be precipitated as hydroxide. Carbonated waters also extract iron from silicate rocks, and from this solution limonite may be deposited. Rusty stains in and about chalybeate springs are explained in this way. Bog-iron waters are also formed in swamps by the help of the organic acids of the soil.[12] From a consideration of the above, it will be readily seen that the iron content of mineral waters, or at least the excess of it, is readily precipitated out, so that a comparatively small quantity remains in solution, except in strongly acid waters, which are related to the mine waters.

**Lithium Waters.**—Lithium waters are usually classified as carbonate, bicarbonate, sulphate and chloride, but here again it should be remembered that it is the *ion* action we are seeking, so the so-called combination is not of so much importance. Although traces of lithium are found in nearly all the igneous rocks, and in the waters of numerous mineral springs, the salts are obtained from the decom-

position of such minerals as lepidolite, spodumene and the lithia tourmalines, but lithia is by no means an abundant element. As its chloride is extremely soluble, we should expect to find it in sea water, and by very careful analysis it has been proven to be there, although in very minute quantities. On account of its therapeutic action, and because lithia forms a soluble salt with uric acid (Chapter X), lithia waters have for many years received much attention.

**Borates.**—Large deposits of borates have been found in some inclosed basins. This substance is present in appreciable quantities in sea water, and it is supposed that from this source most of the great deposits originally came. From an industrial standpoint, the immense lakes and deposits of semiarid lands are very important, but as a constituent of mineral water, except for bathing purposes, borax waters are not considered of much importance. As boric acid is comparatively weak, these waters partake of the alkaline quality of the base.

**Silica.**—Silica, next to oxygen, is the most abundant substance on the crust of the earth, but on account of its comparative insolubility, it is not abundant in mineral waters. Waters containing silica, however, belong to the alkaline class on account of the fact that silicic acid is one of the weaker acids. The amount of silica in sea water is exceedingly small, but there is enough so that siliceous organisms abound in the ocean, although it has been suggested that perhaps they get their silica from clayey matter held in suspension rather than from that in solution in the sea water.

According to Clarke,[13] the analysis of river water generally will show that waters relatively high in organic matter are likely to be high in silica also. From this it has been inferred that the organic matter holds the silica in solution, although the connection between the two is not invariable. It may, however, be that the alleged relation between the silica and the humus is purely coincidental, and that the alkalies are really the effective solvent. It seems to be pretty well established that in case of waters flowing over crystalline rocks the silica is derived directly from the decomposition of the rocks by the carbonic acid held in solution in the water. In earlier geological ages the waters were no doubt of a siliceous type.

Water flowing over feldspathic rocks contains silica as the chief inorganic constituent, although the amount is relatively small. On the other hand, volcanic waters, especially geyser waters, are rich in silica and may contain as much as 0.5 gm. per liter. In natural waters it is assumed that the silica is actually present in the colloid state and not in acid ions.

**Saline Waters.**—Saline waters are defined by Skinner as:[14] "Those which have alkaline or neutral reactions, and contain sulphuric, muriatic or nitric-acid ions in predominating quantities."

In addition to the types of alkaline waters just discussed, there are also alkaline waters that contain considerable quantities of chlorides, making them largely saline in quality, and also sulphated alkaline

waters containing chlorides and sulphates. These mixed types of waters need not be specially discussed here, as they are referred to under the proper classification of the acids or bases.

**Muriated Waters.**—Muriated waters, or those in which the chlorine and the sodium are predominant, are probably the most abundant of mineral waters on the surface of the earth, unless it be the bicarbonate waters. If we refer again to the ocean, which is the great mineral spring, sodium chloride and magnesium chloride are the chief ingredients. The water of the ocean contain 2 per cent of chlorine, which is much in excess of the quantity required to combine with sodium to form common salt.[15] On this account, it is customary to mention magnesium chloride as one of the chief chemical components of ocean water. River water contains an excess of sodium, so the additional chlorine is not from that source. Sedimentary rocks account for many of the elements contained in water; igneous rocks account for the presence of sodium and contain little chlorine. It has been suggested that possibly the early atmosphere and ocean were charged heavily with chlorine.[16] Meteorites, volcanoes, deep springs and solfataras are perhaps the chief source of the chlorine now found in the ocean. According to the latest writers, however, the real original sources of the chlorine in water are still open to discussion.

Chlorine is the most abundant element of the halogen group, and on account of the solubility of its salts is very widely distributed in the crust of the earth and in the waters of the streams and lakes. Human agencies have much to do with the increase of chlorine in river waters, so that a large increase of chlorine in a given period in a well or mineral spring is regarded as suspicious of organic contamination from human sources and should be thoroughly investigated.

**Potassium Chloride.**—Potassium chloride is comparatively abundant in mineral waters, and is found associated with sodium salts and with other chlorides and sulphates in the great deposits of such mines as that at Stassfurt, Germany. In river waters the proportion of potassium is about one-fourth that of sodium, but in the ocean water it is only about one-thirtieth.[17] Starting with the igneous rocks, however, sodium and potassium are about equal. One reason for the seeming decrease of the potassium salts on their way to the sea is said to be that the hydrous salts of alumina, as the clays, take up more potassium from the water as it percolates through the soil than of sodium.[18] This is truly a remarkable provision of Nature, as the plants need potassium for their growth rather than sodium. The result of this curious selection of salts is that the potassium then goes with the sediments and the sodium remains in solution to go onward toward the sea.

**Sulphated Mineral Waters.**—Sulphated mineral waters are very abundant, because, like the chlorides, the salts are very soluble. As sulphur, sulphides and sulphates are abundant in the crust of the earth, the two latter, being soluble, would be found in the waters.

In the ocean bed, and wherever there is a deposit of mud with a salt-bearing water above it, profound chemical changes are continually taking place. It is well known that decomposing organic matter reduces the sulphates of sea water to sulphides, and when these come in contact with carbon dioxide, hydrogen sulphide is formed. The characteristic odor arising from salt-water marshes when the tide is out can readily be accounted for by this simple chemical reaction. Bacteria also assist in this reduction. Some of the hydrogen sulphide reacts on the iron silicates in the deep sea mud to form pyrite, and some is oxydized to sulphates again.

In the more recent formations we find immense deposits of gypsum (a hydrated calcium sulphate), and in the inclosed basins thousands of tons of the more soluble sodium and magnesium sulphates. In mine waters the sulphides of many of the heavy metals and of iron are found, and these give rise to the acid mine waters which are interesting, but not considered as of value as mineral waters. One great source of the soluble sulphur compounds is the decomposition and oxidation of the iron sulphides, pyrite and marcasite. The acid mine water from coal mines, which is so commonly noticed, is due to the oxidation of the pyrite, which is associated with the coal seams.

With regard to waters of this type, Dr. Schweitzer says:[19] "Dolomitic limestones and limestones containing gypsum produce the Epsom and Glauber salts springs; magnesium sulphate and calcium carbonate resulting from their interaction, the former, of which is very soluble and constitutes the main ingredient of the Epsom salt springs, or wells. If the limestones are associated with marls rich in alkalies, or with other rocks containing alkaline carbonates or silicates, the conditions are given for the formation of Glauber salt springs."

The study of the present action of water on sulphates as in the case of the Simplon Tunnel[20] showed that cold water entering the tunnel eroded annually 10,000,000 cm. of gypsum. The stream, known as the Schwatrzegg, after running thirty minutes through the mountain, takes up 2 gm. of gypsum per liter from the rock. With the help of carbon dioxide subterranean waters probably take up as much from the limestone.

Sulphur springs are among the most popular as watering places, perhaps because the water has such a strong odor of hydrogen sulphide, the gas being quite soluble in water at ordinary temperatures, so that the patient is aware that he is getting something radically different from ordinary water. In these waters the sulphur is in the intermediate combination between the mineral sulphur, or brimstone, and the sulphate. This latter when in combination with the metal is often so acid or styptic that it cannot be taken as a curative agent.

**Alum Waters.**—Alum waters belong in this class, as aluminum sulphate or an alkali-aluminum sulphate is the salt ordinarily present. Aluminum is the most abundant of all metals and is an essential con-

stituent of nearly all important rocks except the sandstones and limestones. The great source of the aluminum compounds is the feldspars, micas, clays, bauxite and associated minerals and numerous phosphates and sulphates.

The shales, which result from the finest of the products of sedimentation consolidated, contain aluminous silicates as their most important constituent. From the decomposition of these shales, especially in the presence of pyrite, soluble sulphates find their way into the streams. A more important source of alumina in water, however, is from the alums. When sulphides of the metals oxidize they form sulphuric acid, and this acts upon the aluminous rocks to form aluminum sulphate. Sulphate of iron, nickel, cobalt, zinc and copper may be found in water pumped from the mines where these metals are mined.

**Phosphate Waters.**—Phosphate waters, not being abundant, are of minor interest. Most igneous rocks contain some phosphorus, generally as one of the constituents of the mineral apatite. Phosphorus being an essential constituent of animal bodies, and occurring especially in bones, and since there are large deposits of phosphatic rock, the material for phosphate waters is not wanting in the earth's crust. It has been observed that swamp waters, rich in organic matter, readily dissolve phosphatic rock. Carbonated waters also dissolve it, but a phosphorus compound is again precipitated when the water is brought in contact with calcium carbonate.


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## CHAPTER VI.

# THE RARER SOLID INGREDIENTS AND GASEOUS CONTENT OF MINERAL WATERS.

By E. H. S. BAILEY, Ph.B., Ph.D.

### ELECTROLYTIC DISSOCIATION THEORY OF SOLUTIONS.

The best accepted definition of a mineral water is one that is broad enough to include not only those waters that contain relatively large amounts of common mineral substances but also all "natural waters proposed for consumption on account of their special therapeutic or hygienic properties."[1] With this idea in mind, waters containing rare ingredients that are supposed to have a beneficial effect are also included. Since the electrolytic dissociation theory of solutions has been almost universally adopted, we have still greater reason for the belief that some of these ions, although present in extremely small quantities, may have valuable therapeutic effects. On this account, the discussion of mineral waters containing small quantities of mineral substances should by no means be neglected. Furthermore, those waters "which have a beneficial effect upon the system, when taken in large quantities, by reason of their very purity,"[2] are also properly included.

**Organic Matter.**—Organic matter derived from the decay of vegetable substances, which by further oxidation is converted into carbonic-acid gas, is of common occurrence in waters of some swamps and tropical rivers, and some lakes that are fed by bog waters. In this brown, peaty water the organic material is in a kind of intermediate state, and although many attempts have been made to classify it, and such names as humic, crenic, aprocrenic and ulmic acid have been given to the products, there is little evidence at the present time to prove that they actually exist.

The dissolved organic matter in some of these waters varies from 16.4 per cent of the dissolved solids in the water of Lake Nough in Ireland, to as much as 59.9 per cent in a river in Uruguay.[3] The humus acids are only slightly soluble in water, but very soluble in alkalies. It has been suggested that these waters have been found to be excellent solvents of silica, on account of the greater proportion of alkalies which they contain.

**Ammonia.**—Ammonia is brought to the surface of the earth in quantities of from 1 to 5 pounds per acre per annum,[4] and nitrogen as nitric acid in quantities from 0.35 to 2.44 pounds per acre per annum by the rain. In sea water, nitrogen as ammonia is also found in small quantities. In thickly populated areas the occurrence of large quantities of nitrogen either in the form of ammonia or as nitrates leads the chemist to view the water with suspicion as probably contaminated from sewage.

**Antimony.**—Antimony is not abundant or widely diffused in Nature, and is therefore seldom found in mineral waters. About the only chance for its occurrence would come from the oxidation of stibnite, or a sulphantimonate ore.

**Arsenic.**—Arsenic is not an uncommon ingredient of mineral waters, although it is usually found in small quantities. When such a mineral as arsenopyrite is oxidized and comes in contact with water it readily goes into solution. It is also found in sea water. Arsenical waters would be most naturally found in mineral localities where such metals as antimony, copper, bismuth cobalt and nickel occur, and it is not uncommon to find it in thermal springs.[5] On account of the well-known therapeutic action of small quantities of arsenic, those waters containing even minute quantities of arsenic, are not to be ignored.

**Barium.**—Barium is not an uncommon ingredient of waters. It is found widely distributed throughout igneous rocks,[6] especially as a constituent of the feldspars and micas. Barium is quite a common constituent of soils,[7] as would be inferred from the fact that the ash of many plants and some of the common weeds, contains appreciable quantities of this metal. On account of the relative insolubility of barium sulphate, barium in small quantities only will be found in the sulphate waters.

**Bromine.**—Bromine is of not uncommon occurrence, in natural waters, associated with chlorides and iodides. According to Winkler,[8] bromine is found in the Adriatic Sea in the proportion of 63.8 mg. per liter. The ratio to total halide content is 1 to 288.5. This relation probably holds true for waters from other localities.

The water from salt springs and wells usually contains bromine with other halides and is also present in considerable quantity in the waters of the Dead Sea and in the waters from other inclosed basins. A sample of this brine from a depth of 300 meters[9] contained over 7 gm. of bromine per liter. Brines from Michigan and the Kanawa Valley in West Virginia, and from Pomeroy, Ohio[10] are important commercial sources of bromine. As the bromides are more soluble than the chlorides, the common salt crystallizes out first, and from the mother liquor, called the "bittern," the bromine is recovered by oxidation and distillation.

The quantity of bromine and of iodine in some well-known waters of the world recalculated from grains per gallon to grams per liter[11] is as follows:

| | Bromine. | Iodine. |
|---|---|---|
| Ocean water | 0.410 | |
| Dead Sea | 2.080 | |
| Congress Spring, Saratoga, N. Y. | 0.107 | 0.002 |
| Excelsior Spring, Saratoga, N. Y. | ... | 0.061 |
| Artesian Lithia, Ballston Spa, N. Y. | 0.048 | 0.002 |
| Bromo-magnesium Well, Independence, Kan. | 0.183 | |
| Caxton Spring, Canada | 0.003 | |
| Hygiea, Caix, Germany | 0.123 | 0.041 |
| Adelhaid, Heilbrunn, Germany | 0.006 | 0.025 |
| Cranien, Kreuznach, Germany | 0.201 | |
| Bitterwasser, Kissingen, Germany | 0.091 | |

**Cadmium.**—Cadmium occurs in small quantities in the earlier rock formation, and associated with zinc in many of the mines of the latter ore. Greenockite, the sulphide, is its chief ore. It has been estimated that zinc is 200 times as abundant as cadmium.[12] From the oxidation of the sulphide, cadmium salts, which are soluble in water, would be formed. The analysis of mine waters has revealed the presence of this metal. No less than 17 different elements were found in a mine water from Butte, Mont., by Hillebrand.[13] This particular water contained 41.1 parts of ionic cadmium per 1,000,000 parts of water, which is very much more than most of the mine waters contain. As would be inferred, the water of the ocean also contains minute quantities of this metal.

**Cæsium.**—Cæsium, a rare metal of the alkaline group, something like potassium, occurs in some silicates, especially in the mica lepidolite; it is found in the waters of mineral springs in extremely small quantities. On account of the solubility of its salts, it is also found in sea water.

**Chlorine**—Chlorine in the ionic condition, unites with metals to form salts, and has been discussed (page 106), but in the early stages of the formation of the earth's crust we can conceive of chlorine gas in the elementary state being present in the gases that issued from the earth. This gas would be readily dissolved in water and oxidized after a short time. It would be only under very peculiar conditions that the free gas would be present in mineral waters.

**Cobalt.**—Cobalt, one of the heavier metals, associated with nickel, is a common constituent of igneous rocks, although nickel is by far the more abundant of the two. In 262 analyses of igneous rocks made by the U. S. Geological Survey, an average of 0.0274 per cent of nickel oxide was found.[14] These two metals are also constituents of meteorite iron. They occur in the crust of the earth usually as sulphides, and, as these readily oxidize, the salts would be found in mine waters, and under special conditions might occur in mineral waters.

**Copper.**—Copper is found in small quantities in igneous rocks. It is known to the metallurgist under the form of native copper, sulphides, oxides, carbonates, arsenides and as associated with iron in chalcopyrite and bornite. Copper is found in sea water, in the ashes of sea weeds and in certain corals. From comparatively recent investigations it has been shown that copper is a natural constituent of the flesh of certain mollusks, as the oyster. This seems to be entirely independent of the special contamination of the water by copper salts. Copper is also found in the plumage of certain birds.

The ores of copper are readily oxidized, and the copper may go into solution in water as sulphides. By the action of water containing carbon dioxide, the carbonates might be formed, and from this solution would later crystallize as malachite or perhaps azurite. Mine waters, especially those from mines where copper, iron and zinc sulphides are found, sometimes show large amounts of copper. By

solution in some such way, then, the copper may find its way into streams, wells and mineral springs. Of course the undiluted mine waters would be poisonous if taken internally, except in extremely small quantities.

**Fluorine.**—Fluorine is important as one of the rarer constituents of waters. It is found in the crust of the earth, especially in fluor spar and cryolite. The phosphate, apatite and some of the silicates contain appreciable quantities of fluorine. As in the case of most other elements, fluorine is found in small quantities in the igneous rocks. It is also found in river waters in proportions from 0.02 to 0.6 mg. per liter, according to the analyses of Gautier and Clausmann[15] and according to the same authors in the proportion of 0.3 mg. per liter in ocean water. Analysis of 93 samples of mineral waters from European localities, made by P. Carles,[16] showed that 88 contained more than 0.001 gm. NaF per liter. The maximum was 0.018 gm. per liter. Those waters high in silica contained the least fluorine. Fluorine is also found in volcanic gases.

**Iodine.**—Iodine, although present in small quantities, is frequently found in waters, and is usually associated with chlorine and bromine. The chief commercial source of iodine is the ashes of sea weeds. This means, of course, that iodine is present in sea water, where, according to Sonstadt,[17] it is in the form of calcium iodate. The quantity was estimated at about 2 parts of iodine per 1,000,000 of water. The largest amount of iodine, organic and inorganic, reported by Gautier[18] is 2.38 mg. per liter.

The quantity of iodine in some spring waters is shown by the table on page 73. One interesting fact in reference to the occurrence of iodine is that, although it usually is found in mineral waters in the ionic condition, and we represent it as present as NaI or KI, it is occasionally found as free iodine. A spring at Pahua, New Zealand,[19] contains both free and combined iodine, and Wanklyn reports that the water of Woodhull Spa, near Lincoln, England, also contains free iodine. It is said that the iodine colors the water brown and can be extracted by carbon bisulphide.

With reference to the distribution of iodine in different portions of the habitable globe, it has quite recently been demonstrated that where there is an absence of iodine in the soil and water, on account of the enlargement of the thyroid gland, the disease known as goiter is much more prevalent. As an argument in favor of the ion action of extremely small quantities of this substance, the very small doses occasionally used in these sections of potassium iodide, administered to all the children in the schools, show the belief in this as a preventive measure.

**Lead.**—Lead, one of the heavier metals, may occur in water, especially in mine waters and those seeping out from seams of lead ores. Lead is found in Nature chiefly as the sulphide—galena. When this oxidizes the sulphates and carbonates are formed, and these being

soluble to some extent will be carried away in the water. As an illustration, it is noted that the waters of Spring River in southeast Kansas[20] contains so much of the sulphates of lead and zinc that fish cannot live in the water and it acts as a poison if used for a drinking water.

**Rubidum.**—Rubidum is one of the rare elements allied to potassium. It occurs in feldspar and is found in mineral waters occasionally. In a collection of the analyses of ocean salts given by Clarke[21] the amount of rubidum is given from 0.03 to 0.04 per cent.

**Strontium.**—Strontium is found in Nature associated with barium, calcium and magnesium in the igneous rocks. The sulphate, celestite and the carbonate strontianite are both somewhat soluble in water, and so find their way into natural waters. The ashes of sea weeds have been found to contain strontium salts. It is also found in the water of the ocean.

**Zinc.**—Zinc is often associated with lead in the ores. The principal mineral containing zinc is the sulphide, sphalerite or zinc blende. It also occurs as the carbonate and the silicate. The zinc sulphide is readily oxidized, and the strongly acid water from zinc and lead mines often contains considerable of these metals. As an illustration, the water of Spring River, and of Shoal Creek, in the Joplin District of southwest Missouri, and southeast Kansas, may be mentioned.[22] Frequently these waters contain enough sulphate to be poisonous to man and the lower animals. In one analysis it was shown that the anhydrous saline residue from one of the waters contained 22.31 per cent of zinc, as ion, and in another analyzed by Strokes, 24.8 per cent.

This metal is also found in sea water and in the ashes of sea weed. From the above statements, therefore, it is evident that although zinc would not be considered as a constituent of potable or mineral waters, yet it is liable to be found in them when there is opportunity for drainage from zinc or lead mines or when the water has passed over beds of zinc ores imbedded in the earth.

## GASEOUS CONTENT OF MINERAL WATERS.

**Carbonic-acid Gas.**—Carbonic anhydride, $CO_2$, is found in greater or less proportions in most all cold springs. It is a heavy gas, being one and a half times heavier than the air. Water containing the gas becomes carbon-dioxated, unless some other ingredients predominate sufficiently to fix their character upon the water. Waters containing an excess of this gas have an acid reaction when freshly drawn, and an acidulous, pungent, but very agreeable taste. Its presence imparts a piquant sparkle to the water. The source of this gas has been a subject widely discussed. Delkesiaup[23] holds that to some extent carbon dioxide (carbonic-acid gas) may be derived from inclusions of liquid and carbon dioxide in the quartz of granite and porphyries and set free by heat. It is also probably generated in some places from limestone or other carbonate rocks by the action of acids. The

decomposition of organic matter also gives rise to carbonic-acid gas. In many lava regions there are strongly carbonated springs, and the source of their content of this gas is plausibly considered to be one of carbon dioxide that is occluded in the underlying rocks, for the gas is known to be one of the prominent constituents of the vapors given off during volcanic eruption. Its presence in excess holds in solution an excess of mineral matter, which excess is usually deposited as soon as the underground waters reach the surface, where the carbon dioxide rapidly vanishes into the air.

**Hydrogen Sulphide.**—Hydrogen sulphide or sulphuretted hydrogen gas, $H_2S$, next to carbonic-acid gas, is found as an important constituent in a large number of our most valuable cold and thermal springs. While it usually occurs in a free state, yet it is often found in combinations as sulphides with sodium potassium, calcium or magnesium. This gas gives the "decayed-egg" odor to sulphur water, which in some springs is so strong as to impregnate the atmosphere at a considerable distance. This is an irrespirable gas, and when inhaled in considerable quantities is quickly fatal. This gas originates probably as the result of the reaction of hydrocarbonaceous matter in the strata accessible to artesian veins with such alkaline sulphates as are usually present in solution in the water or by decomposition of some of the sulphides either in the rock or the solution, or in both. In the alkaline waters of volcanic origin (heat) is a contributing cause to its production. Steam and metallic sulphides, often in combination with carbonaceous matter, act upon each other under pressure, and as a result of such action gases are evolved, one of which is sulphuretted hydrogen. It frequently issues from the earth in close proximity to semi-active volcanoes, probably evolved through the decomposition of sulphurets by hot water. In other springs its presence, no doubt, is due to the double decomposition of sulphates in the presence of organic matter.

**Oxygen.**—Oxygen, $O_2$, as free oxygen, is present in all surface and ground water, as shown by the oxidation of organic matter, but its presence is not indicated by analysis. Whether it is present in waters from deep sources is an unsettled question, but the corrosion of iron casings would indicate its presence. Still its presence or absence in mineral waters is of little moment therapeutically. Several of the combinations of oxygen—oxide of iron, oxide of aluminum, etc.—have been mentioned in previous pages.

**Nitrogen.**—Nitrogen, $N_2$, in the form of ammonia is present in water as nitrates and nitrites. The free or uncombined gaseous element, nitrogen, like oxygen, is readily absorbed from the atmosphere by the solvent action of water. In the free state, however nitrogen,[24] unlike oxygen, is chemically inert and, although all surface waters of lakes and flowing streams are saturated with this gas, it exerts no appreciable influence upon the character of the water.

**Ammonia.**—Ammonia, $NH_2$, in surface waters is usually a sign of pollution, and when present in considerable quantities such waters are unsafe for consumption. However, in waters coming from great depths, which are above reasonable suspicion, the presence of ammonia may be high and still not indicate pollution or the presence of decaying organic matter. Ammonia is frequently present in waters, being washed out of the air by rainfall, leached from the soil, or is the result of bacterial decomposition of organic nitrogenous matter. It may also be evolved from organic matter or nitrates within the rock. Smith[25] holds that the presence of extraordinary ammonia can be explained on the basis that the sulphuretted hydrogen has exerted its well-known reducing action, either reducing the higher oxidized compounds of nitrogen back to ammonia or preventing their formation entirely. In most deep waters the ammonia has already passed partially into oxidized nitrates or fully oxidized nitrates.

**Carburetted Hydrogen.**—This gas is found in mineral springs in coal regions and natural gas districts. A carburetted water exerts no beneficial influence therapeutically or otherwise except to render the water unfit for human consumption.

## ORGANIC INGREDIENTS.

Water when passing through the upper strata of the earth absorbs from the vegetable matter with which it comes in contact certain principles, commonly classed collectively as "organic matter" and usually referred to by analytical chemists as impurities. Water containing organic matter, after percolating through the deeper strata, has most of its material filtered out so that when the water emerges as a spring, it is apt to be comparatively free from such matter, except in such infinitesimal amounts as not to produce any deleterious influence when imbibed. Chemists have succeeded in isolating from this organic matter several secondary products which will be briefly mentioned herewith.

**Baregine or Hydrosin.**—Baregine, or hydrosin, is a brownish-yellow residue of organic azotized matter obtained from certain sulphur waters. A solution of it precipitates the salts of lead with silver nitrate, which immediately assumes a reddish tint.

**Glairine.**—Glairine is an amorphous deposit, soft and unctuous to the touch and found in reservoirs where water accumulates. It possesses no action so far as known.

**Sulfuraria.**—Sulfuraria is a confervoid growth, formed in sulphur waters with a temperature below 50° C. (122° F.). In composition it is analogous to glarine and, when burned, leaves a larger amount of silicious matter.

In addition to the above named organic substances, a number of microscopic algæ have been described,[26] though their number is much less in mineral waters than in lakes and impounded reservoirs. The

presence of algæ in reservoirs is responsible for the vile taste and odors peculiar to certain waters. The above organic substances, however, do not apply to the organic matter, due to surface contamination, which frequently finds its way into springs.

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## CHAPTER VII.

# RADIO-ACTIVITY, RADIUM EMANATION IN THE TREATMENT OF DISEASE WITH SPECIAL REFERENCE TO RADIO-ACTIVE MINERAL SPRINGS.

By JOHN C. HEMMETER, M.D., Ph.D., Sc.D., LL.D.

### RADIO-ACTIVITY OF MINERAL WATERS.

It has long been known that mineral waters, especially when taken internally and also when used in the form of a bath, have an effect that is not explainable by the chemical analysis of these waters. Perhaps the reminiscence of my personal experience, in Wiesbaden as a student, may be pardonable to illustrate this point, and explain my early interest in the mysterious effect of the springs at that place, which were known to the Romans. (Pliny, the Elder, 28 A.D., referred to them.) In the years from 1876 to 1882 I was in Wiesbaden as a student, and at one time spent three years there consecutively. I was frequently a guest in the house of Dr. Melchior Kranz, a distant relative, who was not only a keen diagnostician but a practical chemist. In Wiesbaden at that same time the laboratory of Fresenius attracted many young men from all over Europe. The work on qualitative and quantitative analysis by Fresenius was used as a textbook when I became a candidate for the degree of Ph.D., at the Chemical Laboratory of the Johns Hopkins University, under Ira Remsen. It is necessary to state this in order to make clear that Dr. Melchior Kranz had the best obtainable chemical laboratory at his disposal, and the most accurate analysis of the thermal springs of Wiesbaden. When I requested an explanation of the astonishing cures of gout and arthritis and other abnormal conditions, he said to me, "The chemical analysis of these springs and their temperature cannot explain these results. There is something which escapes our present methods, that is active in these waters." I furthermore inquired, "Will you please instruct me as to your personal reason for making this statement?" He replied, "There are several reasons: In the first place, I have artificially made this thermal water by dissolving the exact quantity of the salts that Fresenius found in the same amount of water, and used it for both drinking and for baths; but none of the therapeutic results were accomplished by the artificial water. Secondly, when this hot mineral water, save for that of the Kochbrunnen is allowed to stand in large artificial reservoirs and is used a week thereafter, it is found to have lost much of its effect. Thirdly, patients living at a distance

have had it shipped to their homes in large barrels, but it had lost much of its therapeutic effect after the arrival at its destination. Fourthly, when Kochbrunnen water that has become therapeutically inactive is mixed with mud and sediment from the sides or bottom of the springs it resumes its therapeutic activity to a large part." Thus, this man, nearly twenty years before the discovery of radium, was correct in saying that the thermal mineral waters contained something which had a therapeutic effect and which escaped detection by chemical analysis. The radio-activity of mineral springs was not discovered until 1903 by Sella Pocchettino, J. J. Thompson and F. Himstedt, almost simultaneously with the discovery that air which had been made to pass through water gained in electric conductivity. All spring water and ground water showed this property, but it was absent from water that had been exposed to air for a long time. Later, it was shown that in those waters which increased electric conductivity in the air there was a radio-active gas and emanation which had been taken up by the air, and this emanation was proved to be identical with radium emanation.

**Measure of the Quantity of Radio-activity of Mineral Springs.**—As the emanation is a gas, the factors which determine the solubility of gases in water are of influence on the radio-activity of mineral springs. As a rule, it can be said that a high gas development and salt content go parallel with a low radio-activity. Thermal springs are, as a rule, more radio-active than cold springs; but as high temperature may effect an expulsion of the emanation, it may happen that cold springs appear more radio-active than hot springs, unless the hot spring water is tested immediately after it is taken from its source. A certain relation has been established between the strength of the radio-activity and the geological composition around the sources of the spring. It might be said that clay containing sedementary schists is more favored than sandy strata. Thermal springs that arise from granite are more favored in this respect, and the proximity of recent volcanic eruptions favors the richness of radio-active emanation.

E. Rutherford[1] has called attention to the fact that all bodies surrounded by the radium emanation became coated with an invisible active deposit, possessing physical and chemical properties which sharply distinguish it from the emanation. This property of radium of "exciting" or "inducing" activity in neighboring bodies was first observed by P. Curie[3] and has in recent years been the subject of a number of investigations.

**Active Deposits of Radium Emanation.**—When radium emanation is led into a closed ionization chamber the radio-activity increases for several hours up to twice its original potency, but when the emanation has been blown out by air the chamber still retains a considerable radio-activity which does not disappear for several hours. The first increase of activity is caused by the fact that the emanation successively produces new active substances. These attach themselves to

the walls of the chamber like material substances, and therefore they are called the "active deposit" of radium emanation and their activity is called induced radio-activity. After a removal of the mother substance of the emanation these active deposits are transformed in a relatively very weak substance. It is clear, therefore, that a body that is bathed in radium emanation becomes enveloped with radio-active coating. Rutherford has explained this by an illustration on page 97 of his book.[1] Plates of various materials kept in the neighborhood of a radium salt become radio-active—even such plates as are protected by a lead shield. This proves that induced radio-activity is not produced by direct radiation from the metal radium. If such an induced radio-active plate is rubbed with a cloth the radio-activity passes from the plate to the cloth and can be demonstrated when this cloth is brought over an electroscope or near a fluorescent screen. This phenomenon has been observed by me when towels that have been in the bath chambers of Hot Springs, Va., were brought near an electroscope. It was also observed when human beings, who have just emerged from a hot bath at these springs, were rubbed with a towel that had been brought in from the outside. The towel was tested before and after applying it to the bather. In Hot Springs, Va., it is almost impossible to keep clothing and towels entirely free from induced radio-activity, because the entire structure where the hot radio-active water is used appears to be radio-active; but the towel becomes decidedly more radio-active after a bather has been rubbed down with it. As far the therapeutic effect is concerned, it is evident that it must last for a considerable time after the bath, because the active deposit clings to the patient, and if he has taken any of the water inwardly it is reasonable to suppose that the radium emanation may effect an induced activity on the lining of the gastro-intestinal tract.

**Standardization and Measurement of Radio-active Substances.**—Defective physical and biological methods and a failure to state the exact dosage have been the cause of much confusion in the statements of various experimenters and authors on this subject. No distinction has been drawn in consideration of the earlier literature between the effect of radio-active substances on healthy and on diseased tissues. It is by no means correct to assume that these radiations are ineffective on diseased conditions, when they have been shown to be without effect on animals and men that are in a state of perfect health. It is instructive to cite a few of these mistakes and explain them. It has, for instance, been stated that radium emanation when taken into the body by drinking radio-active water has no influence on the gastric secretion (Olszewski). In order that this statement should be convincing, the effect should be stated before and after drinking the water and the nature of the test-meal, also the description of the methods used, as all dilution of the gastric contents must necessarily alter the chemical constitution of the secretion. One simple test-meal is not sufficient to establish the normal standard secretion of a man or

animal. At least one week of study is necessary for this. Then again, the dosage of the radio-active substance administered should be stated, as some waters are much stronger than others.

**The Dosage Expressed as Mache Units.**—The standard of measurement for the strength of radio-active emanations of solutions for bathing and drinking and of the air for inhalation has been the so-called "Mache unit," which is usually spoken of as the Mu. It is equivalent to $\frac{1}{3\,000\,000}$ part of a millicurie (after Dr. and Mme. Curie). Three thousand Mache units are equivalent to $\frac{1}{1\,000}$ of a milligram of the element of radium.* This is equal to $\frac{1}{1\,000\,000}$ of a gram, and is by consensus of opinion designated as a microgram. In order to understand the standards of the older literature on this subject, it is necessary to state that formerly the radio-activity of uranium was taken as a standard, particularly by the French. The radio-activity of uranium was accepted as equal to 1 and pure radium was 2,000,000 times as great.

Living tissues have frequently been used as the objects upon which radio-activity was tested; Wood and Prime recommended as a standard of 1 unit of intensity of radium the rays that were emitted by 1 mg. of radium element located 1 cm. distant, and they suggest that this be designated as 1 mg. or 1 mc. cm. I have personally found that the resistance of the fertilization membranes of Nereis limbata, that were used by Redfield and Brice to determine the intensity of radiation, varies greatly with the locality from which this organism was taken. All biological test objects are necessarily subject to many atmospheric and physical influences. They are furthermore not always obtainable, especially not in the same condition, and the therapeutist cannot always depend on the coöperation of the physicist and biologist at the same time.

In my study of radio-activity of mineral springs at Hot Springs, Va., made together with Ernest Zueblin,[4] we gave various methods of collecting and testing various Mache units in those waters, and I refer to this article for the method used in collecting and testing radio-active water.

**Ionomicrometer for Determining Radio-activity.**—Most of the efforts at standardization of radiation power have been made with the roentgen-ray, especially since the Coolidge tube has enabled us to secure the desired milliampèrage, as distinct from voltage, and the recently devised apparatus known as the stabilizer prevents the fluctuations in the radiation. In the *Journal de radiologie et d'electrol* (1924, 8, 248) a gold-leaf *ionomicrometer* is described, which enables one to ascertain the radio-active power even of very delicate intensities. It consists of a gold-leaf electrometer enclosed in a small globe of aluminum not more than 12 mm. in diameter. The gold leaf can be seen

*The Council of Pharmacy and Chemistry of the American Medical Association recognizes 2700 Mu. as the generally considered equivalent of 1 micro curie of radium emanation. W. E. F.

through two small glass apertures, using a Zeiss objective of 25 magnifications. This can be immersed in the water if necessary. Szillard, of Paris, has suggested an ionto quantimeter for the clinical measurement of roentgen-rays.

**Caution to be Used in Employment of Radio-active Baths.**—The susceptibility of human beings to roentgen-rays as well as radio-active substances varies so greatly that each individual should be tested by means of an ionto quantimeter as regards the sensitiveness of the skin to roentgen-ray radiation. This will give a clue to the amount of radium emanation that a particular person can endure. When there are many springs in the same place of widely different Mache units' power it is best to begin the baths with the weakest spring. It is a great mistake for bathing resorts to advertise the great radio-active power as an attraction to their particular resort. It is very rare that more than 50 mu. per liter per hour (1250 to 2500 multipled by $10^{-11}$ gm. radium)[4] is necessary in the mineral water to begin with, and it may not be out of place to call attention here that I know of at least one case to have occurred in Joachimsthal, where death resulted from a bath containing 600 mu. The case was that of an obese patient with low blood-pressure. I know of many other instances where patients became extremely prostrated. Whenever there is low blood-pressure, particularly when associated with a slow pulse, high Mache unit baths should be avoided. In case of an accident, in which the patient has become pulseless after the bath, prompt and energetic stimulation is necessary. My best results were obtained by hypodermic injection of an effective preparation of digitalis, together with quinine sulphate internally or the muriate of quinine and urea injected hypodermically. Whiskey has proved effective in a number of cases, but it is by no means an unfailing remedy when the neurovascular innervation is rendered inactive as occurs in these hypersensitive subjects. In one case it was necessary to institute artificial respiration for thirty minutes. Patients with a hypersensitive circulation and weak heart had best not take the baths or drink radio-active waters.

So, even in the use of radio-active baths, inhalation of radio-active steam and drinking of radio-active water there must be an individualizing dosage. Many of the ill effects seen at springs that are not attributed to the water, usually are due to the continuous inhalation of the emanation which is unavoidable, because the air in the sanitaria as well as in the neighborhood of the springs is saturated with these emanations.

**Dosage and Effect on the Tissues.**—Most of the experimenters have not used radium or radium emanation, but have experimented with the effect of roentgen-rays in measured doses. In my report[4] I called attention to cure of cutaneous disorders from the exclusive local or external application of the radio-active waters at Hot Springs, Va. It is, therefore, evident that there is something in these emanations that effects the skin locally, and what has been called the *erythema dose*, is the dose of roentgen-ray that is just sufficient to cause erythema on

an individual. The area exposed to the radiation need not be larger than a dime, but the intensity and time response of the reaction is the practical indication for the tolerance of the individual to radiation.

The dose which destroys carcinoma cells is practically the same as the erythema dose of the skin. The changes produced in tissues by radiation have been described as a necrobiosis of the cells, and if long continued there is a chronic inflammatory reaction which is followed by proliferation of the connective tissues. The changes vary according to the type of tissue, the intensity of the radiation and the time of exposure. Different tissues are affected to varying degree by dosage—character of the ray on emanation and time of exposure and in each tissue the proper dosage, etc., has to be ascertained by cautious and tentative experimentation.

The most sensitive tissues are those in which the cells of the leukocyte types preponderate. Thus the lymphatic tissue, the spleen and the lymph glands are most susceptible. This explains the beneficial results of radium and radio-active substances on conditions caused by enlarged lymph glands. Even asthma, which in some cases is due to mechanical obstruction of the terminal bronchial tubes by enlarged lymph glands surrounding them, can be improved by exposure to roentgen-ray and even by prolonged inhalation of radio-active emanation. The bone-marrow and sex glands are next in order in susceptibility. The mucous membrane of the intestines and stomach are as sensitive as the external skin while the cervix and the corpus uteri require from 30 to 40 Mu.

## DIFFERENCES IN THE DURATION OF EFFECTIVENESS AND THE VARIOUS RAYS EMITTED BY SUBSTANCES OF THE RADIUM, THORIUM AND ACTINIUM FAMILY.

It is hardly necessary to emphasize that the therapeutic effects of these radio-active substances are not due to the substances themselves but to their disintegration products, spoken of as emanations and rays. There are three kinds of rays and these are usually spoken of as: (1) Alpha, (2) beta and (3) gamma rays. They are generally indicated by the Greek letters corresponding to these expressions.

The elements of the radium family possess a decidedly longer duration of effectiveness than those of the thorium group, and these again a greater effectiveness than those of the actinium family. All three radio-active groups have the property in common, that a gas-like disintegration product known as the emanation develops in the course of their breakdown. The duration of life of the emanation corresponds exactly to that of the mother substance. The molecular disintegration does not stop with the emanation but goes on to further and more subtle substances. Those of radium also live longest, while those of the actinium have the shortest duration, only a few minutes. A few remarks concerning the nature of the alpha, beta and gamma rays are necessary.

The alpha rays are helium atoms with positive electric charge; beta rays are electrons negatively charged; gamma rays are electromagnetic ether vibrations. Now the individual radio-active disintegration products are distinguished by the kinds of their rays. Some only send out alpha rays, others in addition send out beta rays and still others send out the gamma rays. Immediately after the production of a

DISINTEGRATION TIMES.

| Element. | Mean duration of effectiveness. | Radiation. |
|---|---|---|
| | *Radium Family.* | |
| Uranium | $5.10^9$ yrs. | Alpha. |
| Radio-uranium | $0.10^6$ yrs. | Alpha. |
| Uran X | 24.60 days | Beta + gamma. |
| Ionium | $2.10^5$ yrs. | Alpha. |
| Radium | 2000 yrs. | Alpha + beta. |
| Emanation | 3.85 days | Alpha. |
| Radium A | 3.00 min. | Alpha. |
| B | 28.80 min. | Beta + gamma. |
| C | 19.50 min. | Alpha + beta + gamma. |
| D | 10.60 yrs. | Beta. |
| E | 85.00 days | Beta + gamma. |
| F (Polonium.) | 136.00 days | Alpha. |
| | *Thorium Family.* | |
| Thorium | $13.10^{10}$ yrs. | Alpha. |
| Mesothor I | 5.50 yrs. | |
| Mesothor II | 6.20 hrs. | Beta + gamma. |
| Radiothor | 2.00 yrs. | Alpha. |
| Thorium X | 3.65 days | Alpha + beta. |
| Emanation | 54.00 sec. | Alpha. |
| Thorium A. | 0.14 sec. | Alpha. |
| B | 16.60 sec. | Beta + gamma. |
| C | 60.00 min. | Alpha + beta. |
| D | 3.10 min. | Beta + gamma. |
| | *Actinium Family.* | |
| Actinium | About 30.0 yrs. | |
| Radio-actinium | 19.5 days | Alpha + beta. |
| Actinium X | 10.2 days | Alpha. |
| Emanation | 3.9 sec. | Alpha. |
| Actinium A | 0.002 sec. | Alpha. |
| B $B^2$ | About 38 min. | Alpha + beta. |
| C | 4.710 min. | Beta + gamma. |

pure radio-active substance the disintegration begins and breakdown products are formed with radio-active qualities different from the mother substance, so that all radio-active substances send out all three kind of rays. The individual types of rays are distinguished by the different reach of effectiveness. Alpha rays only reach a very short distance. They can be deviated from their course by a sheet of writing paper. The reach of effectiveness of the beta rays is greater, and they require a thick aluminum sheet for their interruption. The penetrating power of the gamma rays is so powerful that the same

precautions are necessary as with the roentgen-rays. As far as therapeutic effect is concerned, the different rays are not only distinct qualitatively but also quantitatively. For instance, the beta rays of thorium are very penetrating to the tissue while the beta rays of actinium are very soft.

All of these rays exert very strong chemical effects on organic and inorganic substnaces. The expression applied to them is, "They disrupt the molecular cohesion of the substances." Here the profound problem opens up as to why it is and how it comes about that rays which are invisible to the human eye actually do break down the materials of which this earth is constructed. This is a problem which concerns the physicist.

All radio-active substances have the same property of ionizing the air through which they pass, and thereby rendering it conductive to the electric current. In fact all of our methods of measuring the radio-activity are based on this property. They all have the property of splitting up the salts of silver, as shown by the effect on photographic plates. They are capable of hydrolyzing and oxydizing organic substances that are readily capable of undergoing these processes. They destroy anilin dyestuffs. They disintegrate solutions of albumin. Under proper conditions they break down uric acid.

**Destruction of Uric Acid by Radio-active Mineral Waters.**—In an article on the radio-active mineral waters Dr. Henry A. Mattill[5] discusses the destruction and transformation of uric acid. He cites twenty-nine authors' opinions. Many of the experiments of these authors are rendered futile by failure to comply with the experimental conditions mentioned in the preceding. Dr. Mattill reaches no definite conclusion, which is regrettable from the therapeutic standpoint because clinicians expect the reviewer to stand between them and a vast accumulation of literature and to deliver an opinion based on mature testing and study of the literature. As a matter of fact, men like W. Falta,[6] and von Noorden[7] are among the most eminent research workers on metabolism which medical science has produced. This can also be said of Gudzent.[8] They work in institutions where physicists of world reputation are associated with them, and if their experiments are repeated in exactly the same manner as they describe them the identical results will be obtained by after-workers. Gudzent's statement that uric acid is decomposed by radio-active emanation has been confirmed by Falta in working with highly radio-active thorium preparations. This effect can also be noticed on the blood and urine of patients examined before and after radio-active hot baths.

## THE BIOLOGICAL EFFECTS OF RADIO-ACTIVE SUBSTANCES.

Two kinds of effects have to be distinguished when living tissues are exposed to radio-active substances: (1) The effect of weak radiation, and (2) the effect of strong radiation.

**Effect on Plants.**—Young plants show a marked progress in growth and increase in the chlorophyl content as judged by control plants under weak radiation but strong radiation inhibits growth, according to O. Hertwig. The *effect on lower animals* is similar. Stronger radiation decidedly checks their growth. Highly radio-active preparations have a strong bactericidal effect.

**Effects on Higher Animal Organisms.**—The effect on higher animal organisms are of a manifold nature. Local external radiation of weak dosage constitutes a stimulation to growth and strong radiation leads to tissue necrosis. Special pathological tissues exhibit a special elective susceptibility to the roentgen-rays, and, therefore, the direct radiation of tumors and various skin affections has come into practice.

**Effects on Special Tissues.**—When the radio-active substances are taken into the digestive tract, or actually injected into the circulation, the manifoldness of the biological effects become more evident, for then all the tissues of the body come under the effect of the radiating material, but not all tissues give evidence of the same degree of susceptibility. Some tissues actually show a power for storing the radio-active emanation. This is true of the bone-marrow, and explains the strong influence which radio-active substances have on the hematopoietic apparatus. The organs which give rise to the white corpuscles show a different reaction from those which give rise to the red corpuscles.

**Effect on the Blood-forming Tissues.**—Small and weak dosage stimulates the leukocyte-forming apparatus, so that in most all individuals a distinct hyperleukocytosis occurs in radio-active baths as well as when radio-active air is inhaled. With large dosage, a leukopenia is evident, and with very large dosage a leukocytosis has been observed. In animals in which this has been produced an advanced destruction of the lymphatic tissues was found on microscopic examination.

**Effects on the Erythrocyte Apparatus.**—The effects on the erythrocyte apparatus is much more refractory, for dosage which causes strong leukopenia has still only a stimulating effect on the bone-marrow, and it has been observed that in persons who are professionally occupied with strong radio-active preparations a hyperglobulemia develops.

**Effect on Heart and Bloodvessels.**—Weak dosage, as a rule, stimulates the heart action and causes a transitory vasoconstriction, whereas strong dosage may injure the heart and greatly lower blood-pressure. This is not only a direct effect on heart and bloodvessels, but an indirect effect due to the influence of radio-active substances on the chromaffin tissues and their secretion, adrenalin. These tissues and adrenalin, itself, are extremely sensitive to the Becquerel rays, but the endothelia of the bloodvessels and the endocardium are particularly susceptible. I have observed a condition resembling purpura hæmorrhagica after a prolonged bath in hot radio-active water. I was also called upon to treat a lady who had taken her third bath and was found in a state of collapse in her room four hours after the bath. She was pulseless and no heart sounds could be heard with the

phonendoscope. Digitalis and quinine were administered hypodermically. Artificial respiration had to be kept up for an hour and twenty minutes. Whiskey and carbonate of ammonia were given internally. The heart sounds became audible thirty minutes after the digitalis and quinine were given. In these conditions I urgently recommend quinine because I consider it a heart tonic and vasoconstrictor when there are indications of paralysis of the vasomotor innervation. The vasodilatation can be seen in these cases in the retina with the ophthalmoscope.

**Effect on the Gonads.**—Weak radiation is a stimulant to these tissues in both sexes. Strong radiation may destroy the parenchyma of these glands.

**Effect on Metabolism.**—In the preceding I have discussed the view of Gudzent,[8] Falta,[6] von Noorden[7] on the influence of radio-active substances on uric-acid transformation. The especial sensitiveness of tissues that are rich in nuclear structures would lead one to expect a penetrating influence of radium and radio-active substances on pure metabolism. German, Austrian and French experimenters report that the inner radiation increases purin metabolism and the deposits of uric acid become mobilized and the destruction of uric acid thereby increased. Similarly they report an increase in the respiratory metabolism. In most individuals the oxygen intake and the $CO_2$ output is augmented during and for a time after the employment of radium emanation. American observations, however, do not confirm this. Investigations by Fine and Chace with inhalation of radium emanation (containing as high as 100 Mache units per liter) over long periods, radium emanation in drinking water and injection of 50 mcg. of soluble radium bromide in no case had any influence whatever upon the concentration of uric acid in the blood. Likewise they could observe no increase in the excretion of uric acid in the urine.

Jacob Rosenbloom discusses the effects of radium on metabolism, and comes to the following conclusions:[9]

"1. The intravenous injection of 100 mcg. of radium element produced an increase in the amount of nitrogen excreted in the urine. No constant effect was noted on the percentage excretion of urea nitrogen, ammonia nitrogen, uric-acid nitrogen, creatinin nitrogen, amino-acid nitrogen and undetermined nitrogen.

"2. The injection also caused a marked increase in the amount of total urinary sulphur and in the amount of neutral sulphur excreted.

"3. The effect of intravenous injection of 100 mcg. of radium on the nitrogen and sulphur metabolism lasted for about three days following the injection."

It is well known by physicians at Hot Springs, Ark., and Hot Springs, Va., as well as in Wiesbaden and Karlsbad that tophi of the fingers and toes and ears disappears on the use of the radio-active baths and emanation. Personally, I assured myself in 2 cases that the tophi did consist of sodium urate by incising them and removing part of the contents. It seems to me necessary that the whole subject

of the effects of radium emanation should be gone over again in view of the contradictory results reached by so many biochemists and clinical observers. The laboratory results in these cases cannot be brought into agreement with the clinical observations made at springs that are radio-active. It is especially important that the amount of uric acid in the diet should be accurately known and controlled during each biochemical study.

**Effects of the Constitution.**—The explanations of the constitutional effects vary according to the opinion which observers hold concerning the tissue upon which radio-active emanation acts most intensely. Hertwig believes that it acts on the chromatin of the cells; Swartz, that it acts by destroying the cell lecithin; Packard, that it activates autolytic enzymes; Neuberg ascribes the effect of radiation upon the other intracellular enzymes without corresponding inhibitory effect upon the autolytic enzymes.

Dr. C. I. Reed[10] describes studies on the physiological action of light which, while they have no direct bearing, yet are of indirect interest in this connection. There are two articles by Reed on this subject and the following are his conclusions concerning the effects on arterial blood-pressure of direct irradiation of blood *in vivo:*

"1. Direct irradiation of blood circulating through a quartz tube interposed in an artery will cause a massive depression of general arterial blood-pressure. Animals sometimes die from the shock even when anesthesia has been discontinued.

"2. This result may be obtained in irradiation with a carbon arc rich in ultra-violet or with a spectrum from which has been filtered infra-red rays (longer than 7000 A) or ultra-violet rays below 3300 A. The differences between results obtained with these three spectra are not pronounced.

"3. Since irradiation *in vivo* decreases coagulation time, it was usually necessary to make use of heparin intravascularly in order to keep the radiation tube clean. Heparin modified the average result to some extent."

## FOUR PRINCIPLES OF APPLICATION OF RADIO-ACTIVE THERAPY.

The methods of treatment and the technic have been greatly expanded in the United States and Europe in the last ten years.

1. Direct radiation from the outside or from one of the body cavities.
2. Inner radiation by embodiment of the radio-active principle into the tissues or directly into the circulation.
3. Radio-active inhalations.
4. Radio-active baths.

Nos. 2, 3 and 4 are the methods mostly used at mineral springs. The direct radiation from the outside or from the digestive tract or from the lumen of the bronchial tubes is used in the treatment of

cutaneous disease or of certain tumors of the digestive or respiratory or urinary organs. Personally I have treated carcinoma of the esophagus in a successful manner, in that the life of the patient was greatly prolonged after it had been impossible for him to swallow even liquid food. In cases of carcinoma of the body of the stomach, particularly of the pylorus, it is not wise to attempt this form of treatment, as the stomach is so accessible to the surgeon that radiation could not promise the results that might be obtained by an experienced operator. Direct external radiation is at the present day little used in internal medicine, though in some instances radio-active preparations are effective in neuralgia, in lumbago and in joint diseases where only one joint is affected. The radio-active mud of Bohemia and the same found at the bottom of the springs at Hot Springs, Va., can be used in the form of external applications over painful joints, and the radio-active waters and also the sediment at the bottom of the springs at Hot Springs, Va., are very effective when used in this manner

A favorite local action can be obtained by the injection of a radium salt balanced with about from 1000 to 2000 Mu. in pericapsular residues resulting from chronic arthritis, particularly if only one joint is affected and if the condition is due to the Neisser coccus.

**The Treatment of Obesity.**—Fat patients, as a rule, suffer from an impaired heart action and an infirm reticulo-endothelial apparatus, and from some abnormality of the endocrine system therefore they are not safe patients for treatment with radio-active substances nor even radio-active baths. It appears to me that larger layers of fat in some way disperse the rays to the tissues which we do not desire to affect, and the very large doses that are necessary are dangerous.

**Treatment of Gout.**—When one reflects how long gout has been studied as a human ailment, and the many biochemical investigations that have been concentrated upon the metabolism of nitrogen and especially of uric acid Walter Jones,[12] writing on the nucleic acids, is not definite, and one would expect that more precise knowledge concerning the pathogenesis had been reached. It has been affirmed by Professor His (in his clinic in Berlin) that uric acid occurs in the blood, in gout, in an especially insoluble modification and that radium emanation converted the pathological insoluble form into a more soluble physiological form which is readily destroyed and excreted. The result being a rapid solution of the gout tophi and increased uric-acid elimination and disappearance from the blood (Gudzent and Lowenthal[8]). Speaking of a pathological form of uric acid which is insoluble and a physiological form which is soluble, at first hearing, sounds biochemically correct, but it serves no therapeutic purpose and does not aid the general practitioner to speak of the derivation of the various purin bodies from purin. Those interested in this can instruct themselves in the article by Walter Jones[12] which I have quoted above. As the gout cannot be treated without a very strict diet, and the source of the uric acid in the urine is a double one, the treatment by radio-active substances cannot be expected to be entirely

curative. The uric acid of the urine consists of two parts in its origin: One is called the endogenous uric acid, which is derived from the nuclear substances of the body tissues; the other, the exogenous uric acid is derived from the purin of the foods. Therefore, the most effective treatment is a purin-free diet (vegetables, fat, milk, cheese and eggs). The amount of endogenous uric acid oscillates between 0.3 to 0.6 gm. in twenty-four hours. The amount of the exogenous acid varies, and is proportional to the amount which is taken in the food. This part of the uric acid therefore is most readily controlled. Before treating gouty patients with radium emanations, baths or injections, it is necessary to test the excretory power of the kidneys and to test them for uric acid, according to the method of von Noorden. The characteristic of the gouty patient is that the excretion of the uric acid is not only lower than normal, but it is very much drawn out beyond the time in which a healthy person would eliminate the same quantity. If the capacity of the kidney to eliminate uric acid is very much impaired it would do harm to mobilize uric acid from the deposits within the body, because the cure does not depend upon the starting of the uric acid from its depots but upon its complete elimination from the body. It has been a very frequent experience in my practice that potential gouty patients who were suffering little or not at all were made so invalid by one single radio-active bath that they had to take to their bed. It cannot be too strongly urged that all gouty patients should be tested in regard to their kidney capacity for eliminating uric acid, and if this is less than 50 per cent the patient should be placed upon a non-protein diet for ten days previous to the first radio-active bath; then the elimination of uric acid should be favored by a alkaline-saline laxative. Gouty patients even show severe painful reactions when they inhale radio-active air in so-called emanatorium institutions.

If gouty patients should have high blood-pressure it is bad practice to attempt to favor the elimination of uric acid by recommending that considerable quantities of radio-active water should be imbibed. This is very frequently done under a mistaken conception that free diuresis favors the elimination of uric acid. Plausible as this seems, it is an assumption based upon the functional capacity of the kidneys which should always be tested as I have described in the preceding. With such previous knowledge ascertained, radio-active, warm baths are very helpful and when continued three to six weeks lead to cure.

**Rheumatism, Chronic, Articular, Muscular, Arthritis.**—Chronic articular and muscular rheumatism are the most suitable types for radio-active treatment. As all hot baths are beneficial in rheumatism, particularly if auxiliary, dietetic, mechanical and medicinal treatment are given at the same time, it is not surprising that all resorts with hot springs make a claim for curing these affections. A personal long-continued acquaintance with radio-active and non-radio-active mineral spring waters has convinced me that radio-active waters are far more effective than the profession as a whole realize, and in this country

perhaps none can exceed the effectiveness of the radio-active waters and baths at Hot Springs, Va. These were used by the Indians before the advent of the white man; but there is a very long history, dating back to George Washington's time, who was treated there personally for the rheumatism which he contracted during his campaigns. . . . The primary chronic exudative forms of arthritis are mostly benefited by radio-active treatment. The joints become less painful, more motile and the swelling disappears entirely. It is a common experience that *sciatica* is curable by radio-active treatment if it is continued long enough by baths at the springs.

## DISEASES WHICH SHOULD NOT BE TREATED BY RADIO-ACTIVE METHODS.

There are especially two diseases which should not be treated at institutions where radio-active methods prevail. These are Basedow's, or hyperthyroidism, and diabetes mellitus. I have never seen a case of diabetes improved by a radio-active treatment, and I have regularly seen Basedow's disease become very much aggravated by this form of treatment; in fact all neuroses of the autonomic and sympathetic nervous system should not be treated by these methods. I should also exclude all cases of endocarditis and pericarditis and all forms of cardiac infirmity; also cases with a disposition toward hemorrhage, whether from the digestive tract, from the pulmonary area, kidneys or any other source. All treatments by radio-active water should be carried on in properly conducted institutions, near the springs themselves, and together with the methods of biochemists.

One of the most essential coöperative factors to all such treatment is rest, mental and physical, and severe individualizing dosage and selection of the method.

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## CHAPTER VIII.

# THE DOSAGE OF MINERAL WATERS BASED ON THE DEGREE OF CONCENTRATION.

### CLASSIFICATION BASED ON SALINE CONTENT.

The early writers on mineral waters, Peal,[1] Crook,[2] Walton,[3] Moorman[4] and others, said very little concerning the dosage of these natural medicinal agents from the standpoint of the degree of mineralization. Skinner[5] attempted a classification of mineral waters based on their saline content, avering that a water containing 500 parts per 1,000,000 as very highly mineralized. Grunhut[6] also suggested limits of concentration by which mineral waters may be differentiated from common potable waters; but apart from this little has been advanced on the subject. Dole[9] was the first author to attempt an outline of dosage in relation to the therapeutic activity of mineral waters. The author for some time has been following the scheme herewith as a guide to the chemical classification of waters according to their total saline content, but such a classification is of little value in revealing the therapeutic properties of the predominating chemical constituents. However, Smith's medicinal classification, incorporated herewith, gives an insight into the medicinal properties of the predominating chemical constituents.

| Dr. Smith's Medicinal Classification (Grams per liter). | | The Author's Chemical Classification (Parts per 1,000,000). | |
|---|---|---|---|
| 0.08, very weak . . . | $\frac{1}{5}$ gr. to 5 oz. | 80 . . . | Lightly mineralized |
| 0.40, weak . . . | 1 gr. to 5 oz. | 400 . . . | Moderately mineralized |
| 2.00, medium . . . | 5 gr. to 5 oz. | 2,000 . . . | Moderately highly mineralized |
| 10.00, strong . . . | 25 gr. to 5 oz. | 10,000 . . . | Highly mineralized |
| 50.00, very strong . . | 125 gr. to 5 oz. | 50,000 . . . | Very highly mineralized |

### DEGREE OF CONCENTRATION VERSUS MEDICINAL EFFECTS OF MINERAL WATERS.

We will discuss here some of the relations between the degree of concentration and the possible medicinal effects of mineral waters. The beneficial effects on the human economy of water, both hot and cold, internally and externally, have been fully discussed in other parts of this work. According to Fleig,[7] the ingestion of ordinary water exerts more pronounced diuretic effect than a highly mineralized water. The author,[8] from long years of experience, has found that the ingestion of large draughts of water with the meals stimulates the flagging appetite, increases gastric secretion, stimulates pancreatic activity,

modifies general metabolism, and is attended with beneficial and without harmful results.

There is no doubt that mineral waters exert distinct physiological action due to the inorganic salts held in solution. We have too often witnessed the pleasing results following the administration of these natural medicinal agents, to question their therapeutic potency. The reactions following the ingestion of a mineralized water differ in kind and degree from the reactions following the ingestion of potable waters. Some natural mineral waters exert a cathartic action, some a diuretic action and some a diaphoretic action, etc. The nature and extent of these reactions are solely dependent upon the predominating chemical constituent and its degree of concentration, *just as much so as* the reaction we expect from the administration of any systemic medicine.

The first thought in connection with the therapeutic properties of a mineral water is a careful study of its analysis. The careful analytical chemist accurately determines the radicles present and rigidly searches for even small quantities of the unusual elements. When the identity and the quantity of the radicles are determined he combines the bases and acids according to accepted formulæ, and states his results in the hypothetical combination parts per 1,000,000. This scheme of combination is not an exact science for the analytical data that is insufficient to permit exact apportionment of the acids among the basic radicles to form salts for such combinations, even though made in accordance with the most approved scheme, are more or less arbitrary.

The radicles commonly found in a complete analysis of mineral water are stated herewith. Some may not be present in sufficient quantities for quantitative determination and, besides, other radicles may be present.

LIST OF ELEMENTS.

| *Positive.* Basic radicles (cations), base-forming. | *Negative.* Acidic radicles (anions), acid-forming. |
|---|---|
| Iron (Fe) | Chloride (Cl) |
| Aluminum (Al) | Bromide (Br) |
| Manganese (Mn) | Iodide (I) |
| Calcium (Ca) | Fluoride (F) |
| Strontium (Sr) | Carbonate ($CO_3$) |
| Barium (Ba) | Bicarbonate ($HCO_3$) |
| Magnesium (Mg) | Sulphide (S) |
| Sodium (Na) | Thiosulphate ($S_2O_3$) |
| Potassium (K) | Sulphite ($SO_3$) |
| Lithium (Li) | Bisulphite ($HSO_3$) |
| Ammonium ($NH_4$) | Sulphate ($SO_4$) |
| Hydrogen (H) | Bisulphate ($HSO_4$) |
| | Nitrite ($NO_2$) |
| | Nitrate ($NO_3$) |
| | Arsenite ($AsO_2$) |
| | Arsenate ($AsO_4$) |
| | Metaborate ($BO_2$) |
| | Pyroborate ($B_4O_7$) |
| | Orthophosphate ($PO_4$) |
| | Metasilicate ($SiO_3$) |
| | Hydroxide (OH) |

Analysis of water must be expressed in their probable combinations in which they are intelligible for general understanding, or before their relative concentration can be determined. The expression of results in the parts per 1,000,000 by weight (milligrams per liter or per kilogram) is desirable.

**Examples of Analyses Expressed in Ions and Radicles.**—Below is given the analysis of a prominent well-known mineral-spring water expressed in the radicles and ions parts per 1,000,000. (The ionic theory has been dealt with at length in another section of this work (Chapter IX, page 106)). By referring to Chapter XIV,* it will be seen at a glance the ease with which the degree of concentration of this same spring can be determined in the hypothetical forms of expression, while only the analytical chemist or professional geologist can fully appreciate the concentration in the ionic form of expression.[11]

ANALYSES EXPRESSED IN RADICLES.

| | | Parts per 1,000,000 |
|---|---|---|
| $SiO_2$ | Silica | 29.500 |
| $SO_4$ | Sulphuric-acid radicle | 9.010 |
| $HCO_3$ | Bicarbonic-acid radicle | 194.870 |
| $NO_3$ | Nitric-acid radicle | None |
| $NO_2$ | Nitrous-acid radicle | Trace |
| $PO_4$ | Phosphoric-acid radicle | 0.033 |
| Cl | Chlorine | 5.640 |
| Br | Bromine | Trace |
| I | Iodine | 0.013 |
| Fe | Iron | 1.410 |
| Al | Aluminum | 0.060 |
| Ca | Calcium | 56.680 |
| Mg | Magnesium | 2.84 |
| K | Potassium | 0.71 |
| Na | Sodium | 5.170 |
| $NH_4$ | Ammonium | 0.031 |
| O | Oxygen to form $Al_2O_3$ | 0.050 |
| Total solids | | 309.017 |
| $CO_2$ | Carbon dioxide (free) cc. per 1 | 7.41 |

For the above analysis expressed in hypothetical combinations, see Stafford Springs, Miss.

During recent years extensive investigation has revealed the fact that[9] the reactions following the administration of natural mineral waters are similar to those caused by the radicles in simple artificial solutions, and, furthermore, the magnitude of the reactions are found to be in ratio to the degree of ionic concentration. The physiological actions due to dissolved salts in a natural mineral water can be judged by comparing the concentration of substances with equivalent concentration of Galenical preparations from the apothecary whose doses have been fixed and where physiological and therapeutic action have been investigated clinically and chemically. With these facts established, we have a precedent for working out the dosage of the dissolved salts in natural mineral waters.

* Stafford Springs.

**The Action of Hypertonic and Hypotonic Solutions.**—The action of inorganic salts and the changes produced in the human economy have been treated at length by Professor Cushny,[10] from whose investigation the following brief outline has been adapted from Dole.[11]

Salts have specific action on living tissues in three general ways—stimulants increase and depressants decrease the activity of an organ or function and irritants cause change in condition, as in form, growth, or nutrition, rather than in activity of function. These specific actions depend on the nature, not of the salts or the elements, but of the ions introduced. For example, potassium cyanide (KCN) is poisonous because of the cyanide radicle (CN). Though any other soluble cyanide is poisonous, both carbon and nitrogen in other forms can be ingested without any poisonous action whatever, and if the two elements are administered in solutions in which the cyanide radicle is not present the cyanide action does not occur. The specific action of a salt may be due to one or more of its ions. The action of one ion, either basic or acidic, may be so strong that the action of others is negligible, or both acidic and basic ions may be active, according to the nature of the substance. Besides the specific action solutions of inorganic salts affect tissue through "salt action" by changing the physical properties of the fluids within and without cells. This alteration is chiefly through dialysis caused by difference in osmotic pressure. At the same time, but with less rapidity, some of the salts in solution penetrate the tissues. Therefore, after a solution has been swallowed it takes or gives up water through the walls of the stomach and intestine, according to the relative osmotic pressures of the fluids involved. All cells do not resemble each other in their permeability or in the salt which dialyzes into them, and, though "salt action" is common to all solutions of all salts, various fluids are diffused at different rates and the salts dissolved in them are absorbed with different degrees of rapidity. For example, a weak (hypotonic) solution of sodium chloride rapidly gives up water through the walls of the alimentary canal, thereby supplying fluid to the blood. As the solution administered is increased in strength it yields less water until, when it is very strong (hypertonic), it draws fluid through the surrounding membranes. Sodium sulphate is absorbed very slowly and, for that reason, a strong solution of it acts as a laxative by drawing much fluid into the intestine and thus accelerating peristalsis. Briefly then, salts have physiological influence both by specific action of their ions on the cells and by changing the physical condition of the fluids in contact with the cells.

**The Minimum Dosage of Hypothetical Inorganic Combinations.**—The similarity of action between the therapeutic potency of inorganic salts in natural and artificial solutions is used for the purpose of ascertaining standards of concentration by which to arrive at a definite conclusion, whether a given mineral water possesses therapeutic value by reason of its contained mineral constituents, and, if so, the possible thera-

peutic action of the water. Working on this analogy, the various hypothetical combinations as usually found in mineral waters in which the same ions predominate have been grouped and the minimum dosage computed and expressed in grams. The classification and computation of dosage of combined salts usually found in mineral waters is illustrated in the following table.

COMBINED SALTS.

*Dosage expressed in grams.*

| *Chlorides.* | | *Bromides.* | |
|---|---|---|---|
| Ammonium ($NH_4Cl$) | 0.30 | Ammonium ($NH_4Br$) | 0.65 |
| Lithium ($LiCl$) | 1.00 | Potassium ($KBr$) | 1.00 |
| Sodium ($NaCl$) | 15.00 | Lithium ($LiBr$) | 1.00 |
| Magnesium ($MgCl_2$) | 15.00 | Sodium ($NaBr$) | 1.00 |
| Calcium ($CaCl$) | 1.00 | Strontium ($SrBr$) | 1.00 |
| | | Calcium ($CaBr$) | 1.00 |
| *Iodides.* | | *Arsenates.* | |
| Ammonium ($NH_4I$) | 0.25 | Potassium ($KAsO_4$) | 0.004 |
| Potassium ($KI$) | 0.30 | Iodide ($IAsO_4$) | 0.005 |
| Sodium ($NaI$) | 0.30 | Sodium ($Na_3AsO_4$) | 0.005 |
| Strontium ($SrI$) | 0.50 | Ferric ($Fe_2AsO_4$) | 0.008 |
| Calcium ($CaI$) | 0.06 | Strontium ($SrAsO_4$) | 0.006 |
| *Sulphates.* | | *Bicarbonates.* | |
| Potassium ($K_2SO_4$) | 2.50 | Ammonium ($NH(HCO_3)_2$ | 1.50 |
| Sodium ($Na_2SO_4$) | 12.00 | Sodium ($NaHCO_3$) | 1.25 |
| Magnesium ($MgSO_4$) | 12.00 | Magnesium ($Mg(HCO_3)_2$ | 2.00 |
| Manganese ($MnSO_4$) | 0.25 | Calcium ($Ca(HCO_3)_2$ | 1.00 |
| Ferrous ($FeSO_4$) | 0.20 | Ferrous ($Fe(HCO_3)_2$ | 0.25 |
| Lithium ($LiSO_4$) | 1.00 | Strontium ($Sr(HCO_3)_2$ | 0.30 |
| Calcium ($CaSO_4$) | 2.00 | Lithium ($Li(HCO_3)_2$ | 0.50 |
| *Phosphates.* | | *Oxides.* | |
| Sodium ($Na_3(PO_4)_2$) | 2.00 | Ferric ($Fe_2O_3$) | 0.20 |
| Calcium ($Ca_3(PO_4)_2$) | 1.00 | Aluminic ($Al_2O_3$) | 0.30 |
| Ammonium ($NH_4(PO_4)_2$) | 1.30 | Manganese ($MnO_3$) | 0.20 |
| *Metaborates.* | | *Pyroborates.* | |
| Sodium ($NaBO_2$) | 0.60 | Sodium ($NaB_4O_7$) | 0.75 |
| Magnesium ($MgBO_2$) | 1.50 | Calcium ($CaB_4O_6$) | 0.03 |
| *Nitrates.* | | *Thiosulphates.* | |
| Sodium ($NaNO_3$) | 3.30 | Sodium ($Na_2S_2O_3$) | 1.30 |
| Potassium ($KNO_3$) | 0.30 | Potassium ($K_2S_2O_3$) | 0.80 |
| Barium ($BaNO_3$) | 0.10 | Magnesium ($MgS_2O_3$) | 1.50 |
| *Silicates.* | | *Fluorides.* | |
| Magnesium ($MgSiO_3$) | 2.00 | Sodium ($NaF$) | 0.01 |
| Calcium ($CaSiO_3$) | 2.50 | | |

**Parts per 1,000,000 Synonymous with Milligrams per Liter.**—The dosages expressed above are the averages given by the following authors: Shoemaker,[12] Wilcox,[13] Potter,[14] Fitch[15] and the *United States Dispensatory*.[16] Of course it is understood that more than one minimum dose of any of the above combination of salts may be allowed daily, yet it is assumed that only one dose is taken daily. If the

average dose of sodium bicarbonate is 1 gm., then it follows that a mineral water carrying 250 parts per 1,000,000 (250 milligrams per liter) would require 4 liters of the water for an average dose. If, for instance, a mineral water carries 500 parts per 1,000,000 (500 mg. per liter) of sodium sulphate, and the average dose is 2 gm., then it will require 4 liters of such water for an average dose. A convenient scheme for estimating the degree of concentration of a mineral water, expressed in the hypothetical combination parts per 1,000,000, is to remember that parts per 1,000,000 and milligrams per liter are practically synonymous, and, in studying the analysis, always remember that 1000 mg. make 1 gm., and you have instantly a mental picture of the number of liters of water for the required average dose for one day.

**Antagonistic Radicles in Solution in Mineral Waters.**—It is desirable at this point to outline a few general factors influencing the size and effect of doses of the Galenical medicines—the counterpart of which is commonly found in mineral waters. Dole,[17] discussing this subject, draws attention to the fact that a drug may fail to produce its usual therapeutic action if an antagonistic substance is present, which is often the case in such a complex medicinal agent as a natural mineral water. "Solutions of the chlorides of calcium, sodium and potassium interfere with each other under certain conditions, and this mutually antagonistic action may, in part, explain the tolerance by the human economy for the unusually large amounts of inorganic salts in some mineral waters." Another hindrance, which may not properly be termed antagonistic, but which is decidedly not synergistic, occurs when a water containing one radicle in sufficient concentration to be therapeutically potent and also carries in solution another active radicle of a different nature. For example, a water carrying 300 mg. per liter of lithium and 3000 mg. per liter of the chloride radicle would have little value as a lithia water because of its strong salinity.

"Small repeated doses of certain drugs finally induce symptoms that are more marked than those caused by a single medium dose. Such cumulative effect may be observed in lead poisoning. Most of the ordinary constituents of natural waters, however, are subject to rapid elimination from the body, and therefore this factor is not effective."[17]

**Does an Excess of Alkalinity Neutralize Gastric Acidity?**—Calcium is a normal and necessary constituent of the body, and if the supply of it in the food is insufficient the bony tissues especially suffer.[18] "Though a deficiency is harmful yet, according to Cushny,[19] an excess is little to be feared under ordinary modes of administration, for sufficient calcium to supply the needs of the tissues is absorbed whether the element is ingested in solution or in solid form, and, besides, any excess is excreted by the intestine. An estimate of the minimum effective concentration of calcium in water is unsatisfactory because so little distinctive action can be assigned to this radicle. The smallest average dose of calcium in the form of bicarbonate is 0.3 gm.; as the phosphate, 0.17 gm.; as the chloride, 0.14 gm.; or an average of

0.2 gm., which corresponds to a concentration of 50 mg. per liter of calcium in 4 liters of water. The concentration of calcium that can be tolerated in bicarbonate or sulphate waters used for drinking is at least three or four times greater than this amount. The idea has been advanced that very hard waters are detrimental to health, but experience with them in the United States has failed to substantiate such claim. Berg attempts to show by numerous statistics that people from the districts of Germany, where the drinking water is hard, have better teeth, larger chests and superior physical development than in the districts where the drinking water is poorer in mineral salts."[20]

**The Sodium and Chloride Ions.**—"The sodium and chloride ions have very little specific action, their physiological effect when they are swallowed being due to addition or withdrawal of fluid by osmosis. Sodium chloride in strength not affecting osmosis (normal, isotonic, physiological solution) is a favorite medium for use in the introduction of other substances into the blood by hypodermic injection. Joseph and Meltzer[21] have shown it to be one-ninth to one-nineteenth as toxic as the chlorides of potassium, calcium and magnesium when injected into dogs, for which the fatal dose of sodium chloride was found to be 3.7 gm. per kilogram of body weight, corresponding to nearly 280 gm. of salt for a man of average weight. Solutions of sodium chloride are readily absorbed from the alimentary canal. Weak solutions (hypotonic) are absorbed more rapidly than pure water, which is not absorbed until it has acquired a certain content of salts by diffusion from the blood. Very strong solutions (hypertonic) must be first diluted by diffusion from the blood and afterward the salt must be absorbed."

"The smallest dose of sodium bicarbonate contains about 0.14 gm. of sodium; that of the sulphate, 0.28 gm.; of the chloride, 0.24 gm.; of the carbonate, 0.06 gm.—corresponding respectively to the concentration in 4 liters of water of 35, 70, 60 and 15 mg. per kilogram of sodium; these amounts, however, represent not the activity of the sodium ion but more especially that of the acidic ions with which the base is in equilibrium. So far as salt waters are concerned, it is evident that the problem is more one of concentration than of actual amount of the sodium and chloride ions ingested, and it might be concluded that a solution containing less than 500 mg. per liter of sodium chloride would not interfere with normal osmosis."

"Though potassium arrests the action of the heart when it is introduced into the circulation,[23] it has practically no action on the heart when given by the stomach because it is so rapidly excreted in the urine. Cushny[24] states that much greater quantities of potassium are taken daily in the food of thousands of persons than are ever prescribed in medicine. Salts of potassium in general are so easily dissolved and so readily absorbed that compounds with that base are widely used in the practice of medicine."

**The Sulphides.**—"So little information is available concerning the therapeutic power of sulphides that a minimum effective concentration of the sulphide radicle is not estimated. Cushny[25] states that the ordinary alkaline sulphides are unimportant in themselves, as they are seldom used in therapeutics. He adds that hydrogen sulphide is irritating in the intestine, and thus likely to induce laxative action. Sabbatani[26] found that colloidal sulphur was changed into a sulphate before absorption when it was fed to animals. Coleschi[27] concludes that the increased secretion of gastric juice obtained with mineral waters containing sodium sulphide and hydrogen sulphide, is due to carbon dioxide in the water, as the same waters, gas-free, have no effect on gastric secretion. Researches by Desmouliers and Chatin indicate that sulphur waters increase the power of the blood to dissolve albuminates of mercury and therefore increase the ability of the body to take care of ingested mercury compounds."[28]

**The Sulphates.**—The sulphates in medium large doses produce cathartic action, and they are universally believed to exert this property through "salt action," though some observers, Tyrode[29] among others, holds that catharsis is produced by the action of the salts on the neuromuscular elements of the intestinal canal. He further avers that osmosis plays a minor role, if any at all. Cushny,[30] on the other hand, believes that all compounds in which the sulphate radicle predominates, are less readily absorbed through the intestinal walls than compounds containing the bromides and chlorides. Consequently, when the sulphates of sodium and magnesium predominate in a natural mineral water they draw water from the blood and tissues, thereby diluting the sulphates by osmosis, liquefying the intestinal contents and producing increased peristalsis. The fact that magnesium chloride, while slowly absorbed, also exerts a laxative action, indicates that the magnesium ion possesses cathartic properties. This double action of the sulphates explains why magnesium sulphate exerts a more potent action than either sodium sulphate or magnesium chloride. Ferrous sulphate exerts astringent action in moderate doses, yet in overdoses produces purgation.[31] The sulphates most abundant in natural mineral waters are calcium, magnesium, sodium and potassium. The three latter are more important therapeutically. The smallest dose recommended is 1.5 gm., which should be in a water of such concentration that it can be taken in one large draught, otherwise the radicle would not be in sufficient concentration to produce laxative action. Nevertheless, according to the scheme outlined, the minimum dose of from four to sixteen times that concentration would, in all probability, produce excessive bowel action. Contrary to the opinion of numerous authorities on mineral waters, that calcium sulphate exerts no specific therapeutic action, the author holds there is no good reason for questioning the laxative action of the sulphate radicle in a calcium water. It is known that this salt is slightly soluble in pure water, but is soluble to a much greater extent in solutions of the

alkaline chlorides, and there is no reason for denying that the sulphate radicle in a calcium water may not exert slight laxative action on the bowels. Of the thirty or more preparations of magnesium used as internal medicines, more than 50 per cent are used chiefly for the acid radicles, the magnesium serving as a base. The other half of the magnesium compounds are cathartic in action, and they produce this laxative action, through the "salt action" that takes place (osmosis) because the magnesium ion is slowly absorbed through the walls of the gastro-enteric tract. The slow absorption of magnesium sulphate accounts for its harmlessness when administered per oral route. Meltzer and Auer[32] have reported that the magnesium ion is highly poisonous when introduced into the blood stream. When large doses of magnesium are given internally a large proportion of the salt is excreted unabsorbed along with the evacuations. Cushny[33] believes the portion which is absorbed is, in all probability, excreted through the genito-urinary tract. The magnesium compounds most frequently found in mineral waters are the sulphates, the chlorides, the bisulphate and the carbonate and the oxide. The last two compounds,[32] are very insoluble, and become active only when dissolved; a portion is changed in the stomach into magnesium chloride and another part may be dissolved in the intestine through the action of the carbon dioxide found there.[32]

**The Bicarbonates.**—The bicarbonates are used principally as antacids. When a carbonate compound reaches the stomach it reacts with the hydrochloric acid of the gastric juice, and carbon dioxide is evolved, which, in sufficient amounts, slightly irritates the stomach, leading to increased appetite. Dole[34] suggests that excessive alkalinity of water ingested would tend to reduce the acidity of the gastric juice and lead to digestive disturbances. However, he says, it is not at all uncommon for waters in limestone regions to carry as much or more than 70 parts per 1,000,000 of the bicarbonates, and yet one need worry little over this situation. Halliburton has shown that the normal gastric juice carries as much as 2000 parts per 1,000,000 of hydrochloric acid.[35] Therefore waters carrying from 70 to 100 parts per 1,000,000 of the bicarbonates would have little neutralizing action on the normal gastric juice.

**Compounds of Iodine and Fluorine.**—The compounds of iodine and fluorine, similar to bromine, derive their action chiefly from the acidic ions. The iodide radicle is usually given as the iodide of ammonium, calcium, magnesium, iron, manganese, sodium, strontium or potassium. Waters containing this element are classed as alterative, having a marked influence on the nutrition of the tissues. The fluoride radicle exerts a powerful irritant action, and, therefore, is little used as an internal medicine, though it is sometimes administered in the form of sodium fluoride.

**Boron Compounds.**—Boron compounds generally exert antiseptic action, though the pyroborates have been used medicinally, as the

pyroborate of calcium and sodium. It is the custom of analytical chemists when reporting mineral-water analyses to express all the "boron" as one or the other of the two common radicles "metaborates" or "pyborates."

**Compounds of Arsenic.**—The compounds of arsenic exert tonic, alterative and reconstructive properties. This powerful poison is used medicinally as arsenic trioxide, ferrous arsenate, ferric arsenite, sodium arsenite, potassium arsenate and arsenite, and the chloride, bromide and iodide in minimum doses varying from 0.25 to 1.25 mg. The maximum daily dose is limited to 5.2 mg., the quantity that would be consumed in 20 liters of water carrying 0.322 mg. to the liter such as Crocket's arsenic lithia water.

**Lithium Compounds.**—Lithium compounds are numerous, there being some thirty, but only a few of them are found in natural mineral waters, and from this few we will eliminate the arsenate, bromide and iodide because their acidic ions exert the distinctive medicinal properties of their arsenic, bromic, or iodic acid radicles. This leaves the following salts of lithium which exert lithic action: Lithium chloride, lithium nitrate, lithium bicarbonate and lithium sulphate. The minimum average dose of these salts is about 1 gm.

**Manganese Compounds.**—The compounds of manganese found in natural mineral waters are the sulphate, bicarbonate and oxide. They are alterative and reconstructive in action and useful in the treatment of anemia and chlorosis.

**Barium Compounds.**—Barium compounds are highly poisonous and limited in their medicinal usefulness. According to Cushny,[33] they are very slowly absorbed from the alimentary canal, and only the nitrate and chloride are used internally and limited to the treatment of arterial disorders. The smallest dose is 3 mg. and the largest daily dose considered safe is 150 mg.[36] It will be observed then that a water carrying 0.7 mg. of barium per liter might be classed as "baric" from its barium content, and a water carrying from 8 to 10 mg. of barium per liter, when imbibed might exert strong barium reaction, provided there were not antagonistic radicles in solution in the water.

**Nitrates.**—Compounds carrying nitrates of sodium and potassium are markedly diuretic in action, and at the same time possess diaphoretic properties. The *ammonium compounds*, chloride and carbonate, are stimulating expectorants, and are rapidly absorbed from the alimentary canal. Ammonium sulphate is more slowly absorbed, and, like the other sulphate compounds, stimulate cathartic action. All ammonium compounds are eventually converted into urea and excreted through the kidneys.

**Sulphite Compounds.**—The sulphite compounds exert antiseptic action by withdrawing oxygen from the organic matter and becoming sulphates, and as such they are absorbed and eliminated, as a consequence of which large doses might produce laxative action.

**Thiosulphates.**—The thiosulphates of calcium, magnesium and sodium exert slight antiseptic action, but after all there is little difference from the therapeutic viewpoint between the action of sulphites and thiosulphates.

**Iron Compounds.**—The most common iron compounds found in mineral waters are ferric chloride, ferrous sulphate, ferrous bicarbonate (ferrous ammonium sulphate and ferric subsulphate, though rarely found, may also be added). The compounds of iron are essentially astringent and tonic in action. The bicarbonate of iron is the most easily assimilated and readily absorbed of all the iron compounds. The dose is 0.3 gm.; therefore, a water such as the Buffalo Lithia Springs water from Spring No. 3, carrying 65 parts per 1,000,000 (65 mg. per liter), would require 2 liters per day for the usual dose.

**Aluminum Compounds.**—Aluminum compounds are found in most natural mineral waters, the chloride, sulphate and oxide combinations prevailing. Aluminum waters are usually acid in reaction and astringent in action. The average dose of the sulphate, though little used, is 0.15 gm., and a water such as the Rockbride Alum Springs, carrying 336.9 parts per 1,000,000 of aluminum sulphate, would require less than $\frac{1}{2}$ liter of water in twenty-four hours. In large doses, 2 to 4 liters, active laxative action is produced by the "salt action" of the sulphate radicle.

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## CHAPTER IX.

## THE PHYSIOLOGICAL ACTION OF MINERAL WATERS.

*The ionic or dissociation theory* of the physiological action of mineral waters is viewed from the standpoint of considering the mineral constituents as ions. This theory, we believe, is opening the way for a better understanding of the therapeutic value of these natural medicinal agents. Heretofore, in determining the therapeutic properties of a mineral water, we have been too much under the domination of analytical chemistry, and in forming our deductions of its physiological action we have been more or less biased or cramped on account of our limited knowledge of the electrolytic dissociation theory, which offers an entirely new conception of the relation of radicles, or ions, in various solutions. Although chemical analysis, while giving us definite information of the mineral constituents of these waters, yet it does not reveal the precise state of the salts held in solution.

According to the ionic theory, chemical salts in very dilute solution are completely split up into their ions, so that all of the properties of these solutions must be the sum total of the properties of the separate ions. We know that in concentrated solutions much of the salt remains in the undissociated state; therefore, only a small percentage becomes dissociated ions, whereas the great majority of mineral waters, being weak solutions of chemical salts—the chemical constituents—are chiefly, if not entirely, in the majority of waters in the form of ions, and in this form the physiological effects and therapeutic potency may be quite different from that of the undissociated salts.

*Ionic dissociation* does not, therefore, change the percentage composition of a salt, but may substantially change or modify its therapeutic potency, so that in all probability the ions, rather than the salts—*per se*—are responsible in greater part for the specific effects of mineral waters. If the therapeutic potency of a natural mineral water depended alone on its watery constituent, it is questionable if invalids would have sought the curative influences of the various natural mineral springs which have successfully stood the test for centuries past.

An ion is an atom or group of atoms or parts of molecules forming a complex individual, carrying a charge of electricity, and constituting one of the elements of an electrolyte. In all probability they are evolved by the dissociation of larger electrically neutral molecules into smaller ones, conducting, respectively, equivalent charges of positive and negative electricity. In all solutions the sum total of positive ion charges must be equally balanced by an aggregate sum of

negative ions present. In all solutions there is some specific solvent property, by virtue of which, it penetrates between the parts of molecules and separates them into ions. Those which take on positive charge are termed cations, and those assuming a negative charge are called anions.[1] A simple illustration, for example, we find in hydrochloric acid, a solution of which is made up not only of HCl molecules, but also of H ions and Cl ions. When such a solution is completely dissociated it would be put down as H+ and Cl−. It is a fact, however, that while in a solution of hydrochloric acid there are dissociated chlorine ions, it does not contain free chlorine in the condition met with in a solution of chlorine gas. In solutions of a chloride the existence of chlorine cannot be demonstrated by its physical properties, but its presence can always be recognized by its reactions. The fact that all chlorides, by reason of their chlorine, yield a certain set of reactions which are precisely the same, whatever the associated element may be, is regarded as proof of the correctness of the dissociation theory. Since all chlorides thus give off free chlorine ions in solution, notwithstanding that each one in its solid condition is characterized by its own special properties, it becomes clear why they present a common set of reactions.

**Water, the Universal Solvent.**—With the exception of hydrogen dioxide, water, the universal solvent of the body, brings about the most thorough dissociation of molecules into ions. The ions act as molecules, and thereby increase osmotic pressure. The ions are not formed by the current, but must necessarily be charged with electricity, otherwise they would not conduct the current. Besides certain ions are always charged with positive electricity, and others are negative, but no ion is known which at one time is positive and at another negative.

## PHYSIOLOGICAL AND CHEMICAL ACTION OF ELECTROLYTES.

The physiological as well as the chemical action of the electrolytes have been found to be entirely dependent upon their constituent ions, quite irrespective of the nature of their molecules. For example, all acids are characterized by H ions, as a result of which they all have certain general properties, while the difference between the solutions of different acids containing the same number of H ions depends upon the difference between their anions. The cation of acids is hydrogen; the anion of bases is the hydroxyl group (OH). The fact is then that the physiological effects of an electrolyte are fairly well determined by the character of its ions. While the principal therapeutic properties of most of the chemical constituents of mineral waters are quite well understood, it is of importance to know why, or how, it is they produce their special effects, and, so far as the electrolytes are concerned, the "ionic dissociation theory" would seem to largely supply such knowledge.

It is now held that very dilute waters are sometimes the most active, and much importance attached to the form in which the ingredients are held in a more or less dilute solution. Fox[2] holds that "water has the power of fluidifying or rendering motile, the majority of the solids." This fluidification, as in the case of vaporization, is associated with loosening of the mechanical and chemical structure of the particles. This process, as applied to salts, is described as dissociation. Water further has the property of taking up molecules produced in this manner between its own molecules, rendering them fluid and motile, dissolving them and increasing their chemical activity.

Moreover, these separated particles, or ions, whether bases or acids, carry positive or negative electrical charge, and do not exhibit the usual properties of the free elements. In a solution of completely ionized sodium chloride, for instance, neither the cation (sodium) nor the anion (chlorine) exhibit the properties of these elements in the free state. It is noteworthy that the degree of ionization is in the proportion to the dilution of the solution. In many medicinal waters it is supposed that the saline constituents are in a complete state of ionization.

*The physio-chemical action* of these ionized chemical salts in mineral waters maintain a level of osmotic pressure best suited to the various cellular body activities. The relation of osmotic pressure to distribution of fluids in the tissues and to the processes of resorption and secretion is a very important one.

From the foregoing we have some slight insight into the ionic dissociation theory of the physiological action of mineral waters, and an inkling into the remarkable effect of waters of low mineralization, and an understanding of why the free motility of the ions may be so essential to active metabolic processes.

**Colloidal States.**—The chemical constituents of many mineral springs as revealed by analysis do not always account for the beneficial effects such waters produce on the human economy. It is, however, quite probable, according to Fox,[2] that the action could, and will be explained when the arrangement and combination of the various elements, the form in which they are presented for absorption in the tissues, and the power which one may possess in modifying the proper effect of another, have been ascertained. The "hydromineral action" (French term) of a water seems to be due to the constitution of the combinations resulting from the dissociation of the molecular elements of the water rather than to its total mineralization. Besides, we know that substances while in isolation may sometimes be inert, but that they become active when combined with other and different bodies. For instance, it is known that iron is therapeutically active when combined with the bicarbonates of a water of complex constitution. Likewise sulphurous and alkaline waters seem to promote the activity of mercurial compounds in the treatment of specific disease, as practised at some of the thermal sulphurous spas.

**The Colloidal Action.**—It is believed by European hydrologists that thermal waters hold in solution metallic substances in a colloidal state. According to this hypothesis, there are present in solution in mineral waters many constituents of metals which are insusceptible of the ordinary methods of analysis. Fox[2] thinks that certain of these metallic substances exert bactericidal action, and probably other intimate effects on the tissues that are not comparable to their action in bulk. The loss of activity of such waters when bottled for a considerable time may, probably, be accounted for by the destruction of the organic matter and the deposition of the metallic elements.

Iscovesco discovered colloidal arsenic in arsenical waters, and other workers have found colloidal matter in sulphurous waters. It is well known that colloidal metallic solutions possess catalytic action. Hence, in line with these pronouncements, colloidal metallic solutions in medicinal waters may be regarded as ferments. Robin believes they are capable of physiological action far beyond the proportion of their quantity. Therefore, they may operate in dosage heretofore considered inert. They may, after absorption, modify chemical action associated with morbid states, and may, according to some observers, occupy an important place in the therapeutics of the future. Whatever may be the outcome of this hypothesis, there are certain springs whose waters exert curative action which cannot be accounted for by the chemical constituents as revealed by analysis. "Many mineral waters coming from unknown depths in the bowels of the earth have been subjected to enormous pressure, intensive heat, forcible gas tensions, surcharged with catalytical and electrolytical energies which endow them with peculiar therapeutic properties. From the depths of the magma below they bring tremendous forces to the surface, which human ingenuity cannot understand and but faintly appreciate."

**The Absorption and Excretion of Water.**—The loss of balance between the ingestion of water and its excretion from the body represents a pathological condition. It is quite important for the welfare of the patient and the reputation of the physician for the latter to see that the output of urine almost equals the intake of water. When the excretion is considerably less than the intake the retained water leads to *edema.*

The human body is a complex system of colloids that is highly charged with water, but the mere drinking of water will not increase the amount of water these colloids will take up.

*How Edema is Produced.*—We can bring about this pathological condition by increasing the capacity of the tissue colloids for water, so that when water is offered them they will swell. There are many conditions which increase the water absorbing capacity of colloids. Abnormal acid accumulations increase the hydration capacity of the tissue colloids. The injection of acid into an animal will lead to the development of a generalized edema. Other pathological conditions

which lead to water retention in the tissues are all such as lead to the abnormal production and retention of acid in the tissues, as, for instance, in heart disease, in respiratory affections, circulatory affections, passive congestion, intoxication following an anesthetic, intoxication from the toxins of infections, disease, etc. The normal human body has a definite salt concentration. If we increase this salt concentration the tissues give up water with loss in body weight. Therefore, the important point from a therapeutic angle is that, as we can reduce the water-consuming capacity of cells and tissues through the administration of various salts, so also the abnormally high water content in edematous states can be reduced by the same means. The administration of a sulphated saline cathartic water will produce watery discharges, causing the normal body to give up water; likewise it will make the edematous body or organ give up water, so that we have a rational explanation of the beneficial action of this class of waters in the treatment of edema. The fact must not be lost sight of, that an edema is a self-limiting condition; the organ involved will take up water only to the saturation point of its colloids. Not until these colloids are saturated to their capacity will any water be left over to be excreted as urine. If water is withheld hoping to reduce an edema the urine and sweat will be scant. Contrary to prevailing opinion, water instead of increasing edema may in the aggregate more likely decrease it. Free diuresis carries off with the urine substances which if not excreted would augment the hydration capacity of the tissue colloids, thus decreasing the hydration capacity and accordingly the edema.

**The Relationship Between Absorption and Excretion of Water.**—To clearly understand the relationship between the absorption of water from the intestinal canal and its subsequent secretion by the kidney we must bear in mind the following facts. The cells of the intestinal tract will not absorb water if they are already saturated with water. These cells produce carbonic acid which renders them capable of taking up water from the walls of the gut. But, as "the blood circulates through the intestinal mucous membrane the carbonic acid diffuses into it." This diffusion of carbonic acid into the blood stream decreases (*a*) the capacity of the colloids in the mucous membrane to hold water, and (*b*), increases the capacity of the blood stream to take up water. Fischer estimates that 1 liter of blood passing through the intestinal tract, where it changes from arterial to venous blood, will take up in this way 17.5 cc. of water. Under these conditions, as long as the circulation is maintained, and as long as the cells produce carbonic acid, the intestinal tract will absorb water. Accordingly, therefore, the higher the carbonic acid (or other acid) content of the circulating medium, the greater will be its capacity for taking up water. It is quite evident then that water is best absorbed from the large intestine, where the blood is highly venous in character, and the absorption will be less in the small intestine where the blood is not so markedly venous.

The absorption of water by the stomach is practically *nil*, due to its rich supply of arterial blood. A watery secretion can be gotten from arterial blood only when its carbonic (or other) acid content is low. The venous blood enriched in carbonic acid and water in its passage through the intestinal tract, loses the acid as $CO_2$ when it reaches the lungs. At this junction the colloids of the blood loose their capacity to hold water, and this newly oxygenated arterial blood with its "free water" rapidly passes to the kidneys where it is excreted as urine.

**The Excretion of Urine During Starvation.**—During starvation the secretion of urine practically ceases, because the colloids of the body are saturated and there is no ("free") water left over to be excreted by the kidneys; it will not be possible for any water to reach the kidney until the tissues undergo a gradual consumption, or their colloids suffer changes which impair their water-holding capacity.

When the body colloids are saturated with water if an additional quantity is ingested the excretion of the urine (sweat or moisture exhaled from the lungs) will equal the amount of water drunk. We see, therefore, that the tissue colloids must be saturated with water before there is any excess available for urine (or sweat); when this is accomplished the urinary (sweat) output will equal the amount of water imbibed over and above the quantity required for the saturation of all the body colloids. It must be remembered that the blood stream is not the never-ending supply of urine that many people imagine. In all diseased conditions where mineral waters are prescribed the physician should always ascertain that the output of urine equals the intake of water—otherwise there will be water retention and edema.

**Metabolism of Water Absorption.**—Water and the salts which it holds in solution are absorbed throughout the small intestine, from the pylorus to the ileocecal valve. The absorption of water and its salts from the intestine does not follow the strict laws of osmosis. It passes rapidly into the hepatic bloodvessels which always contain a larger percentage of water than any other bloodvessels of the body. The amount of water imbibed and the rate of its ingestion regulate the rapidity of absorption. If a large quantity is rapidly ingested, a sensation of fulness and weight is experienced, the absorbents are inundated by the overflow of water and endosmosis is hindered, if not entirely prevented. At any rate the process is seriously obstructed. The temperature of the water also influences its absorption. If the temperature of the water is much warmer or considerably cooler than the body temperature it rapidly penetrates the absorbents, but, on the other hand, if the water is the same temperature as that of the body it produces nausea and may even be rejected by the stomach. Waters highly mineralized are absorbed more slowly than ordinary potable waters. When ordinary potable water is ingested in large quantities it acts principally as a diuretic. It flushes out the kidneys and genito-urinary tract and increases the excretion of urea, phos-

phates and chlorides. If the weather is warm it also produces diaphoretic action. This action of waters, in general, is not due alone to mineral waters, as is sometimes imagined. It has been observed in an experiment conducted by Genth that when a large quantity of water (4 liters) is imbibed in the twenty-four hours, the temperature of the body is lowered and the pulse-rate falls and the respiratory action is diminished.

**The Influence of Temperature in Absorption.**—The temperature of the water drunk bears a close relation both to its action on the system and its rate of absorption. For instance, cold water stimulates peristaltic motion of the stomach and intestines, while hot water does not. Therefore, certain mineral waters when taken cold produce laxative action of the bowels, but if ingested hot will not stimulate bowel action. In small quantities hot water increases the pulse-rate and lowers blood-pressure.

**The Influence of the Gaseous Content of Mineral Waters.**—Waters containing considerable carbonic-acid gas, and alkaline in reaction, when given cold exert a sedative, soothing action both on the stomach and arterial system, while the same waters taken hot, and those highly charged with sulphuretted hydrogen, will prove stimulating. Some sulphur waters, carrying considerable organic matter, are decidedly sedative in action. Waters containing sodium chloride, sodium sulphate or magnesium sulphate in large quantities, act readily on the intestinal tract. The alkaline calcic waters are antacid and diuretic in action, and some of them stimulate kidney function. Again, certain waters are cathartic or diuretic in action, according to the time and method of administration. For instance, a water containing comparatively small amounts of purgative salts, combined with calcium sulphate, will exert a cathartic action if taken before breakfast, say two or three large glasses; but if the same quantity be taken in small amounts through a period of several hours only a diuretic action will be observed, and the bowels will not be stimulated. Sulphur waters stimulate the integumentary organs and produce marked diaphoresis. This action is increased if the temperature is high and decreased if it is low.

**Mineral Waters as Alterative Medicines.**—Alterative medicines in appropriate dosage modify the nutrition of the body without antecedent phenomena. They are specific medicines. The long-continued use of mineral waters in moderate dosage produces the effects of alterative medicines. This specific action is readily understood when we consider the constitution of the body and have a clear knowledge of the pathology of the patient's ailment. It might be profitable here to recall that our bodies are so much water in combination with varied proportions of carbon, oxygen, hydrogen, nitrogen, sodium, calcium, potassium, magnesium and other mineral elements. The water thus combined we will term the water of constitution, and may be likened to the water of crystallization, which continues a crystal in its integrity.

The watery content of the human body comprises about 60 per cent of the whole body weight, and in health remains practically at this point. Of course, a certain percentage is excreted daily through the urine, feces, perspiration and exhalations, but an amount equal to the outgo is imbibed to quench thirst and ingested with our food.

*All potable waters* contain an insignificant quantity of mineral salts, and when used to quench thirst these salts reach the system, but are in such infinitesimal amounts that they produce no definite medicinal action. But when a patient is sent to a spring or spa for its alterative effect many times more water is consumed, and therefore the quantity of chemical constituents may be increased, even a hundred fold. The water thus consumed slowly, but surely and regularly, penetrates every bloodvessel, capillary and tissue of the human structure, gradually replacing the water of constitution, and with its contained chemicals influences the whole molecular organism. It is not claimed that all of the chemical constituents of a mineral water are retained by the system. Doubtless a cumulative action results daily, and in the course of weeks or months this cumulative action brings about a decided result, its alterative effect, revealing an increased metamorphosis of tissue, by the elimination of poisons and toxins, and a complete return to health.

**Specific Action of Special Classes of Mineral Waters.**—All classes of mineral waters produce positive specific action, peculiar to the predominating chemical constituents of the water. This alterative action varies with each class just as the alterative action of mercury, iodine or arsenic differ. Each class exerts its specific action on diverse portions of the human body—blood and tissues. The alterative action of alkaline waters brings about a reduction of fibrous element of the blood; saline waters stimulate the glandular system; sulphur waters act on the integumentary system; chalybeate waters increase the hemoglobin content of the red blood corpuscles; alkaline-saline waters with a high sulphate content stimulate bowel action. In like manner, the alterative action of mineral waters varies with the various subdivisions of these natural medicinal agents. Haywood and Smith,[3] in their admirable classification of mineral waters, offer the following résumé, slightly changed by the author.

## ALKALINE WATERS.

**The Carbonated or Bicarbonated Alkaline Waters.**—This is one of the most important groups of mineral waters. This class of waters stimulates the secretions of the digestive tract, neutralizes hyperacidity of the stomach, increases metabolism, dissolves uric acid and uric-acid deposits, increases the flow and overcomes the acidity of the urine. They also exert antacid and diuretic effects.

**Sodic Carbonated and Bicarbonated Alkaline Waters.**—Sodium carbonate or bicarbonate appears as a normal constituent of the blood,

lymph and practically all of the secretions of the mucous membranes. In any disturbance of metabolism which causes any of these fluids to become acid, this class of water is of great value in neutralizing this acidity. The sodic bicarbonated waters increase metabolism, dissolve uric acid and allay irritation of the mucous membranes of the whole genito-urinary tract, with the elimination of uric-acid deposits and uric-acid sand and gravel.

**Potassic Carbonated and Bicarbonated Alkaline Waters.**—This class of waters has very similar physiological action to the sodic carbonated. They increase metabolism and dissolve uric acid and uric-acid deposits, but their properties for increasing the solubility and elimination of uric acid greatly exceeds the former class. The potassic bicarbonated waters exert diuretic, antacid and antilithic effects, especially on bladder calculi.

**Lithic Carbonated and Bicarbonated Alkaline Waters.**—Lithium rarely occurs in waters in large enough quantities to be a predominating basic constituent, still it does appear in sufficient amounts to exert some clinical therapeutic action. These waters are active diuretics, and it was once thought to combine with uric acid and to form the urate of lithia, which is easily and readily eliminated from the system, but this is now an exploded theory.

**Magnesic Carbonated and Bicarbonated Alkaline Waters.**—These waters act as mild laxatives and are, perhaps, the best of all the carbonated alkaline waters for correcting an acid condition of the stomach. Their physiological action favors the elimination of uric acid and the disintegration of uric-acid deposits in the bladder, and allaying irritation of the mucous membrane of the urinary organs. Increased uric-acid excretion is always regarded as a good omen, provided it is not due to increased uric-acid formation, which may result from an increased consumption of foods containing purin bodies, alcohol or even certain drugs.

**Calcic Carbonated and Bicarbonated Alkaline Waters.**—This class of waters is quite different in its physiological action from the carbonated waters just previously mentioned. The foregoing waters are evacuant in action and stimulate secretions, while this class constipates and decreases secretions of the mucous membrane of respiratory, digestive and urinary tracts. A spring rich in calcium bicarbonate would exert curative properties in an obstinate case of chronic diarrhea.

**Ferruginous Bicarbonated Alkaline Waters.**—The bicarbonated iron waters are, of all the chalybeate waters, the most agreeable to take, and the most efficient in action because of their prompt and easy assimilation by the system, due in large measure to the combined free carbonic acid contained in these waters. These waters increase the hemoglobin content of the blood and, in connection therewith, increase the temperature, pulse and body weight. They increase the flagging appetite and promote bodily vigor, and reduce intestinal activity.

## ALKALINE-SALINE WATERS.

**Muriated Alkaline-saline Waters.**—These are especially valuable in the treatment of catarrhal conditions of the mucous membrane of the stomach and intestines, biliary passages and urinary tract. They increase the flow of urine and the excretion of uric acid. Von Noorden[4] and other investigators claim that the use of these waters do not affect protein metabolism.

**Sulphated Alkaline-saline Waters.**—These, like the muriated alkaline-saline class, are valuable in the treatment of catarrhal conditions of the mucous membranes. They are diuretic in action and in large quantities increase peristaltic action, liquefy the intestinal contents and promote slight purgative action without unpleasant after-effects. They exert a stimulating action on intestinal peristalsis and stimulate the excretion of bile. They are obviously of great help in promoting a proper function of the stomach, and aid the action of synergistic Galenicals which may be indicated. This class of waters acts on the circulation of blood in the liver, assuages catarrhal and inflammatory changes in the gall-bladder and bile duct, dilutes the bile and promotes its secretion. They improve the tone of the muscular tissues of the bile ducts, and thereby assist in the expulsion of excrementitious matter.

## SALINE WATERS.

**Muriated Saline Waters.**—This class of waters stimulates the secretions of the mucous membranes of the stomach and intestines, increases the digestive action of the stomach, favors a more complete absorption of the foodstuffs and acts as a diuretic. The free administration of this class of mineral waters leads to an active increase in the production of hydrochloric acid; but, on the other hand, strange as it may seem, in cases of hyperacidity the moderate use of these waters lessens the production of hydrochloric acid and a decrease of the subjective symptoms.[4]

**Sodic Muriated Saline Waters.**—These waters when heavily charged with sodium chloride are admirable for brine baths to increase the action of the skin and, by absorption, act as a tonic. These waters are always diluted when used internally. They act by increasing the production of gastric juice, improve the appetite, increase the secretion of the urine, augment the excretion of urea and prevent putrefactive changes in the intestinal tract.

**Lithic Muriated Saline Waters.**—Such waters would exert the usual physiological action of the muriated saline class—increase the digestive function, favor more complete absorption and assimilation of the foodstuffs, overcome acidity and exert an intensified diuresis, due to the lithium element.

**Calcic Muriated Saline Waters.**—These waters usually contain sodium as a predominating basic constituent, along with notable

quantities of calcium and occasionally magnesium. These waters exert a diuretic action, promote the flow of urine, sweat and bile, increase perspiration and tone the system.

**Sulphated Saline Waters.**—These waters, as a class, exert a laxative or purgative action, according to the quantity administered, and should be taken only in moderate amounts. In small quantity a laxative action is produced, while large dosage favors free purgation. Therefore they are especially valuable where long-continued stimulation of intestinal activity is desired without stimulation of the vascular system. These waters are aperient in action, and by reason of the contained sulphates, metabolism is encouraged by the chlorides.

**Sodic and Magnesic Sulphated Saline Waters.**—These waters stimulate the flow of the intestinal fluids and of the urine, and greatly increase the elimination of urea. In small doses they exert a pleasing laxative action; in large dosage they produce free purgation. These waters are of great value in eliminating syphilitic, scrofulous and malarial poisons from the system, and in throwing off mercury and other metallic poisons. These waters stimulate the secretions of the intestinal canal, liquefy the fecal contents and reduce the albuminous constituents of the body when long continued in large amount.

**Potassic Sulphated Saline Waters.**—While potassium may be present in sufficient quantities in the sulphated waters to be given notice, yet no springs are known in which it is a preponderating basic element. However, it is often present in sufficient quantities to produce its therapeutic effect, which is similar to the salts last mentioned.

**Calcic Sulphated Saline Waters.**—These are what is known as the permanently "hard" waters. The sulphate radicle in a calcium water, contrary to some observers, does exert laxative action.

**Calcic Sodic Sulphated Saline Waters.**—The preponderating element in these waters is calcium sulphate combined with calcium bicarbonate and potassium carbonate. These waters exert a carminative action of the stomach mucosa, dissolve and eliminate mucus from the stomach and bowels. Its physiological action relieves kidney irritation, rapidly facilitates diuresis, increasing kidney function. Their action promotes interchange of fluids, and salts in the tissues modify secretions and excretions and stimulates oxidation and cellular activity. They also exert diuretic, antacid and disintegrating effects on gravel and calculi; the urine is rendered less acid and less irritating and much less likely to deposit urates, and thus the tendency to form stone is then decreased, and when present the solvent action will gradually disintegrate stone formation.

**Ferruginous Sulphated Saline and Aluminic Sulphated Saline Waters.**—Iron and aluminum usually occur together, when either is present as a predominating metallic constituent in sulphated saline waters. Since these waters, carrying large quantities of iron and aluminum together with sulphuric-acid ions, are practically always acid, it is proper to consider them under the sulphated acid group.

## ACID WATERS.

**Ferruginous Aluminic Sulphated (Acid) Waters.**—This group of waters is principally of ferruginous aluminic sulphated class, although there are a few acid springs which contain comparatively little iron and aluminum, but quite large amounts of calcium, sodium or magnesium, and a few springs contain free sulphuric and hydrochloric acids. These waters exert slight astringent action on relaxed conditions of the mucous membranes, especially when characterized by chronic diarrhea and dysentery. The ferruginous waters of this group exert the usual effects of iron waters as already described under the ferruginous bicarbonated alkaline group. The latter group is far preferable, since they are pleasant to take and more easily absorbed and more readily assimilated, while the former are styptic to the taste and not readily assimilated.

**Iodic and Bromic Waters.**—Sodium bromide and sodium iodide are found associated with sodium chloride, and are quite subordinate to the excess of the latter salt; and since iodine and bromine usually accompany each other in mineral waters, they should be considered together. Waters of this class possess decided alterative action. They stimulate the lymphatic system to greater activity and promote absorption in all the tissues. Their physiological effects also favors the elimination of mercury and other metallic poisons from the system.

**Arsenic Waters.**—Arsenic waters increase the appetite and digestion, and improve the whole nutrition of the body. They stimulate the secretion of the gastro-intestinal mucous membrane and restrain destructive catabolism.

**Silicious Waters.**—Little is known of the physiological action of this class of waters, since they have not been thoroughly investigated. Reports from a few investigators seem to indicate the possibility of medicinal value in some forms of cancer, but further research will be needed before this can be definitely determined. Again, other investigators claim that their use has caused albumin and sugar to disappear from the urine.

## GASEOUS WATERS.

**Azotized and Oxygenated Waters.**—All waters that have come in contact with the air contain nitrogen and oxygen, but owing to their limited solubility they can only exist in waters in limited amounts, and their presence does not add to their therapeutic action.

**Carbon-dioxated Waters.**—This class of waters contains free carbon dioxide, and are to be differentiated from the carbonated or bicarbonated waters which contain carbon dioxide in combination. Frequently the heavily carbon-dioxated waters are also bicarbonated, but this is not always the case. Practically all natural waters contain free carbon dioxide to some extent, while in some waters it is present in very large quantities. Such waters are pleasingly palatable, and very large quantities can be drunk without the usual feeling of "ful-

ness." This class of waters stimulates the salivary glands, increases the flow of saliva and of the intestinal fluids; and promotes peristaltic action of the stomach, thereby increasing the digestive function. They also exert a diuretic action and increase the excretion of the urine. Being antacid, they tend to check nausea and vomiting.

**Carburetted Waters.**—Carburetted waters are sometimes found in coal mines, and they occur most frequently in natural gas regions. They have no known therapeutic value and are usually considered unfit for human consumption.

**Sulphuretted Waters.**—This class of waters are characterized by the presence of hydrogen sulphide or the sulphides of sodium, calcium or magnesium. These waters increase the action of the skin, intestines and kidneys. The action of these waters improves the appetite and stimulates the gastric functions when there is a moderate content of sodium chloride, but if there is an excess of calcium sulphate present symptoms of indigestion will arise.

**Radio-active Waters.**—Since the discovery of radium by the Curies it has been proven that most all waters coming from great depths contain radio-active emanations. Waters charged with this gas are known to have circulated through beds of ore containing radium and its salts, thus absorbing the gaseous emanations from the crevices and pockets where it has accumulated. Like all other indifferent respirable gases, radio-active emanations are physically soluble, the degree with which it is taken up depending upon the coefficient of absorption, temperature and pressure. When inspired into the alveolar spaces of the lung it swiftly passes from thence into the circulation and is rapidly carried to the myriad cells of the body, which, according to their ability, rapidly take up the emanations.

Waters containing radio-active emanations,[5] when imbibed pass directly through the walls of the stomach and intestines, passing thence by diffusion into the capillaries of the lymph and portal venous system. Comparing these two methods of administration, inhalation and drinking, by the former the emanation is rapidly absorbed and quickly excreted; but by the latter, absorption into the blood is not so rapid, and its exit from the system is relatively much slower. Final excretion is not completed for some hours, elimination being accomplished *via* the bowels and bladder. The energizing effects of radio-active emanations on the body ferments is most remarkable. Such water appears to be endowed with the power of energizing or activating the body ferments or enzymes, in other words they stimulate to greater efficiency the proteolytic and diastatic ferments and set in motion that long chain of cleavage processes in the various foodstuffs, the necessary prelude to their absorption, assimilation and ultimate transmutation into living protoplasm. Furthermore, radio-active emanations increase autolytic, diastatic, glycolytic, urolytic, pancreatic, peptic and lactic acid fermentation.

## THE SCIENTIFIC ADMINISTRATION OF WATER.

If it is desired to increase the weight of the blood column, to augment the tension of the vascular system, to increase capillary pressure, water should be ingested in small amounts, repeated at frequent intervals of from twenty to thirty minutes for a considerable period of time. On the other hand, if it is desired to cause the disappearance of fluid effusions and to stimulate effective absorption, it may be accomplished, as inconsistent as it may seem, by the administration of water in large quantities at intervals of from six to eight hours, with complete abstinence from all drink during the interval. By this method of administration the blood becomes more consistent and more impoverished in water and best suited to take up fluid from the tissues and to facilitate absorption and elimination.

*The rapid absorption* brought about through the scientific administration of water is not confined to the elimination of fluid alone, but augments the excretion of the solid products of exudation and inflammation. Thus it may not only be possible by the systematic administration of water to bring about the disappearance of dropsical conditions, but also to secure the elimination of waste products, such as urea and other nitrogenous materials. It has been observed, after the generous administration of water, that the loss from the system of both solids and fluids is increased; if the quantity of the aliment is not enlarged, or even restricted, the blood in order to regain its normality must regenerate itself, in part, from the body tissues and not alone from the circulating medium. This leads to retrogressive metamorphosis, with elimination of waste products.

A moderate increase in the ingestion of water with scientific supervision of the dietary leads to an increase of body weight, and thus constructive metamorphosis is stimulated. But, on the other hand, if excessive ingestion of water is permitted, the body weight declines; however, it may soon be restored, if only the proper amount of water is allowed. The ingestion of cold bicarbonated alkaline water exerts a diuretic effect upon the kidneys. Through this increased elimination of fluids from the urinary tract, the solid constituents of the urine are excreted in larger amounts, particularly urea, and thereby the metamorphosis of the nitrogenous tissues of the body is increased. This diuretic action increases the oxidation processes, bringing about a reduction of the amount of uric acid evolved and eliminated. Likewise the amount of oxalic acid is reduced and may even disappear altogether through the increased administration of water.

The stimulation of oxidation processes following the increased administration of water can be determined by estimating the quantities of carbon dioxide eliminated and the amount of oxygen absorbed. In like manner, salts and inorganic substances, such as the potassium salts, resulting from muscular metabolism, and the incombustible

salts, from the bones and the phosphates and sulphates, from the brain tissues and glandular structures, are excreted in large quantities.

The ingestion of cold water stimulates active peristaltic action of the intestinal tract, increases the circulation of the blood supplied to the stomach and intestines, and also augments the rapidity of the flow of blood current in the portal vein, thereby favorably influencing the functions of the liver and stimulating an increased flow of bile.

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# PART II.

# CROUNOTHERAPY.

## CHAPTER X.

## THE THERAPEUTIC APPLICATION OF MINERAL WATERS IN THE TREATMENT OF DISEASE.

### MINERAL WATERS AS COMPLEX REMEDIES.

In prescribing mineral waters for the relief of diseased conditions, the fact must not be overlooked that we are using much more elaborate and complex remedies than those obtained from the apothecary; moreover, their use at a health resort is under such favorable circumstances that a "drinking cure" becomes a therapeutic method. The "drinking cure" at many resorts gives relief in many chronic diseased conditions far beyond the expectations of the patient, or hopes of the family physician. The curative potency of some waters is due, in part, to the radio-active emanations with which the waters are charged. Furthermore, an adequate explanation, either by the analytical chemist of the peculiar composition of mineral waters, or by the therapeutist of the specific activity of each of their mineral constituents, is yet to be given. It is true that pharmacological investigations have revealed a fairly good working estimation of the physiological action of the sulphate of sodium, sulphate of magnesium or the bicarbonate of iron, conveyed to the body even in slightly mineralized medicinal waters. It is now fully realized that the mineral constituents of waters are active because of their presence as ions, rather than as the salts *per se*, and that the combination of several substances, though chemically different, but exerting similar action, is, by reason of this fact, enhanced in curative value.

### THE DAYS' DOSAGE IN MINERAL-WATER THERAPY.

It is advisable when ordering mineral waters to prescribe the days' dosage in several potions, so as to favor absorption and stimulate the activity of the tissues and to augment the secretory and excretory processes. When prescribing "drinking cures" through the use of mineral waters two important facts should demand the attention of

the physician: (1) In prescribing mineral waters we are using medicinal agents, possessing powerful qualifying actions upon the individual, diseased organs and their vital processes, and at the same time influencing to a marked degree the functional metabolic process of the whole system; (2) that it is the duty of the prescribing physician to thoroughly understand the pathology back of the patient's ailment, so as to intelligently regulate the qualifying effects of the water in accordance with each patient's requirements and susceptibility; as well as to understand the modification of irritability induced by the diseased condition present. The pleasing effects and therapeutic efficiency of "drinking cures" at mineral-spring resorts can be greatly multiplied when combined with the proper dietetic supervision, special attention to general hygiene and well-regulated exercise, outlined in accordance with the requirements of the patient's physical condition. Thus the combined effects of climate, diet, hygiene, exercise and the "drinking cure" bring about improvement with restoration to health and happiness, so that the spring resort becomes a Mecca for individuals suffering from chronic disease.

## DISEASES OF METABOLISM.

**Scrofulosis.**—Scrofulosis may be described as a constitutional state, occurring in the young, marked by a lack of resisting power of the tissues, predisposing to tuberculosis; lymphatism is present and there is a proneness to eczematous eruptions, ulceration, glandular swellings, respiratory catarrh, etc. Two types are recognized: The *lymphatic*, in which there is a tendency to fat, with a coarse, muddy complexion, thick lips, coarse hair and stolid expression, where the thyroid cachexia predominates; the *sanguine*, in which the skin is clear, changing readily from pale to pink, the eyes clear and hair fine and silky, slim of figure, vivacious mentality and full of energy. The object of the "drinking cure" with mineral waters in such cases is improvement of the general metabolism. In disorders of metabolism of this type the internal use of sodic muriated waters and the bicarbonated muriated waters is especially recommended, because the sodium chloride contained in these mineral waters stimulates protein metabolism; furthermore in the severe cases of scrofulosis marked by a preponderance of glandular involvement with localizations in the skin, bones or joints, the administration of sodium chloride water containing iodine and bromine, is indicated, because the latter elements, "alterative in action," stimulate the activity of the lymphatic glandular system, and increase the power of absorption in the glandular organs. The dosage of these strong sodium chloride waters, containing iodine and bromine, should be determined with care, the degree of concentration should be determined by a careful study of the analysis and the dose based on the degree of concentration (Chapter VIII, p. 98). In the milder types

of scrofulosis the mild alkaline, muriated, bicarbonated waters, with a low sodium chloride content, and carrying iron in solution, are to be preferred to the stronger waters just mentioned.

Anemic girls, at the pubescent age, with a scrofulous tendency and without involvement of the vascular system may, with advantage, drink of the ferrous bicarbonated waters. In the treatment of scrofulous individuals great stress must be placed upon balneotherapy, which stimulates the activity of the skin and aids in increasing metabolism and favoring absorption.

**Obesity.**—Obesity is characterized by an excessive deposition of fat in the subcutaneous connective tissues. It is now generally accepted that 20 per cent of obesity is due largely to too much indulgence at the table and too little exercise, and 80 per cent due to dysfunction of the ductless glandular system. The successful treatment of the former type of obesity depends upon a properly selected dietary, suitable exercise, and the administration of a sulphated saline water in liberal quantities containing predominating amounts of sodium and magnesium sulphates. In the latter types of obesity the general treatment outlined for the former and the proper administration of polyglandular therapy will secure the best results. In all cases of obesity hot thermal baths are an adjuvant to the treatment as also is the electric-light baths, through the production of increase in metabolism and of elimination by the skin. The free administration of alkaline-saline water characterized by large quantities of the sulphates of sodium, magnesium, etc., is especially indicated in cases complicated with intestinal stasis. Such a "drinking cure" of from four to six weeks' duration, will not only bring about a marked reduction in the amount of fatty tissue, but also exert a favorable influence upon the circulatory organs by increasing the flow of urine and producing alvine discharges of a liquid or semiliquid character.

The dosage of these mineral waters in obese patients should be carefully determined. In the main it is important to see that the amount of fluid eliminated is within the estimated amount ingested, so that the obese patient shall partake only of so much water as he is capable of freely eliminating within a short time.

For the anemic individual, with marked obesity, pasty complexion, the administration also of an iron water is advised. Sodium chloride waters carrying sodium sulphate and iron make a valuable combination and eventually bring about pleasing results. The Carlsbad and Kissengen obesity cures may also be advised in these cases.

**Diabetes Mellitus.**—Diabetes mellitus is a disturbance of metabolism in which the glucose cannot be utilized in the normal way. Owing to this, a patient, on an ordinary diet, develops hyperglycemia and begins to excrete sugar in the urine. Most often the pancreas is at fault, but the kidney (renal diabetes), the central nervous system (piqure diabetes), the chromaffin system, the liver, the thyroid and the hypophysis may also act as causative factors.

**Pancreatic Glycosuria.**—Pancreatic glycosuria results from a far-reaching fibrosis of the islands of Langerhans in the pancreas, though other pathological processes, both acute and chronic, may lead to the symptom-complex. There are but few, probably no cases, of diabetes mellitus, without pancreatic insufficiency.

**Renal Glycosuria.**—Renal glycosuria occurs when the kidney loses its ability to prevent glucose elimination. Edema of the feet and ankles is not an infrequent symptom. Generally anasarca is rare, however, owing to marked polyuria.

Without further reviewing the various problems involved in the causation and pathology of this condition, it may be stated that experience has shown that mineral waters often exert an extremely favorable influence, suppressing entirely or appreciably diminishing the elimination of sugar in the urine, as well as aiding metabolism and otherwise improving the general state of nutrition. The fact that certain waters of the thermal alkaline class, rich in sodium bicarbonate, have been employed with much favor in these diseases, evidences the wisdom of their use. The best results have been obtained in pancreatic diabetes with the so-called Vichy waters—those containing the alkaline bicarbonates and also carrying free carbon dioxide. Such waters, used as a "drinking cure" will produce favorable effects when the organism still possesses sufficient powers of resistance; when the digestive apparatus is performing its normal functions and when a generous meat diet can be taken and metabolized. Under such a régimé diabetics, who previously to the use of mineral waters were passing sugar in the urine on a mixed diet, may, through the influence of the mineral water, acquire a greater tolerance for sugar and starches; besides, patients, who passed large amounts of sugar on a pure meat diet, may, following the use of the alkaline thermal waters, excrete no sugar at all or much less than formerly. The thirst during the "drinking cure" diminishes, the dryness of the mouth becomes less annoying, the flow of urine less abundant, insomnia disappears and the patient gains in strength and weight. In the more advanced cases the use of the alkaline thermal waters have only a limited usefulness. In cases of diabetes presenting anemic symptoms the use of the bicarbonated iron waters is indicated. Ferruginous hot baths are also recommended on account of their favorable influence upon hemogenesis. In cases of chronic glycosuria occurring in corpulent individuals with gouty tendencies, the alkaline sulphated saline waters are indicated. It has been claimed that whatever benefit arises from the use of mineral waters in this disease is due to the resulting improvement in digestion and assimilation, and not to any specific influence of the water; this may, or may not, be the fact. It is also known that mineral waters charged with radio-active emanations are possessed of curative properties in glycosuria. One author reports 182 cases with 160 cures, while Von Noorden says, "Radio-active emanations seem to hasten the dietetic treatment to an extraordinary degree."

It is questionable whether mineral waters offer much hope in the treatment of glycosuria of renal origin, or due to brain injury or brain tumor. When renal lesions exist as the only accompaniment of organic change there is never hyperglycemia as in ordinary diabetes mellitus. The renal function is depleted and sugar leaks through, as it were, and escapes in the urine. The presence of nephritis in gouty subjects, with diabetes mellitus, does not mean that the nephritis is the provocative factor in causing the diabetes. Both are dependent upon the same constitutional metabolic fault, though one may aggravate the other and influence the outcome of the case. A mineral water of the alkaline-sodic-calcic class will aid metabolism, and in this way alleviate distressing symptoms and complications, especially acidosis, which is often present.

No one today believes that mineral water possesses the power of curing diabetes. Its value lies in the fact that for at least a month or more the diabetic sojourns at a spring or spa and drinks the waters and, while undergoing certain dietary restrictions, notices marked improvement in his conditions. It is quite natural under such conditions, for the glycosuria to decrease and his carbohydrate tolerance to increase. In some cases the improved tolerance may last for some time after returning home, but when the dietary restrictions are disregarded the carbohydrate tolerance will soon be lost. In addition, at the health resort there is an absence of unrest, worry, and business cares, which tends to diminish the general nervous tension and to weaken the harmful nervous stimuli.

"The drinking cures" at resorts, however, are of real use for the future welfare of the patient. During his sojourn at the spa he has learned to order his life, and especially his dietary, according to the needs of his case, and if he follows this, his improvement will be more lasting. This type of patient can be benefited most at spas which have a special sanitorium department, where this class of patients can be scientifically treated. It is a mistake for resort owners to exaggerate the curative properties of a mineral water in conditions such as this, as it constitutes a source of danger for the diabetic, who is liable to imagine that he has done all that is necessary for his health, and so does not put a curb on his diet or on his general condition of existence.

**The Uric-acid Problem.**—The uric-acid diathesis may be said to be a hypothetical condition due to a disturbed cellular metabolism. It is characterized by an excess of uric acid in the blood and clinically by various digestive, circulatory, respiratory, genito-urinary, integumentary, arthritic, hepatic and nervous phenomena. In the human body uric acid is the chief end-product of nucleoprotein metabolism, and in the urine it forms by far the greater part of the purin bodies present. This condition of disturbed metabolism has been described by various eminent authorities as "uricemia" (uric acid in the blood), "uric-acid anemia" (an excess of uric acid in the blood), "lithemia"

(the presence of uric acid in the circulation), "purinemia" (the presence of purin or xanthin bases in the blood), "collemia" (the presence of urates in colloid form in the blood), and "uric-acid uria" (the presence of large amounts of uric acid in the urine). While dozens of volumes have been written advancing as many theories to clear up the pathogenesis of the "uric-acid" diathesis, we are not much nearer the solution of the problem than were the older writers of a quarter of a century past.

The formation of uric acid was formerly held to be an intermediate product in protein metabolism, but its specific origin was not clearly indicated until the purin groups were discovered; later researches have shown it to be the *end-product* of nucleoprotein decomposition, that is to say, that the purin bases are the final cleavage products. Uric acid in the body arises from two sources: (*a*) Endogenous, arising from the nuclein containing substances within the organism; (*b*) exogenous arising from the nuclein containing substances in the dietary. (See also page 292.)

Free uric acid is insoluble and is found only in hyperacid urine. It is held in solution in normal urine as the ammonium, sodium and potassium salts, that is, as urates. Approximately 10 per cent of the total amount of purin bodies in the urine consists of purin bases, the remainder uric acid. The treatment here to be relied upon is a purin-free dietary,[1] and the administration of a sodic, calcic, lithic, bicarbonated and sulphated alkaline water, which will render the urine alkaline and aid in the excretion and elimination of uric acid.

**Gout.**—There are a number of disorders of metabolism of which gout is possibly the most prominent example which are believed to originate from an excessive formation of uric acid in the system, or to its retention in the blood. This disordered condition of metabolism is primarily due to faulty digestion and malassimilation, with consequent derangement of the processes of nutrition. The object in the treatment of this condition is to counteract the underlying derangement of metabolism, to overcome the excessive formation of uric acid, and to stimulate its elimination from the system, and at the same time to relieve symptomatically the distressing discomfiture in the joints, muscles, tendons and fascia, due to the deposit of uric acid therein. In the acute stage of the disease mineral waters are not indicated, but, after the subsidence of an attack, the uric-acid phase of the condition being determined, the alkaline bicarbonated waters, carrying lithia, sodium, magnesium and calcium, should be given. These salts being very soluble, readily combine with the uric acid and eliminate it from the system. At this stage of the treatment, it is desirable to stimulate the emunctories which can be accomplished by administering one of the alkaline sulphated bitter waters. Occasionally, a mineral water will be found possessing all the elements desired for this double purpose—

[1] Dietotherapy, vol. 3.

of eliminating the uric acid from the system. The annoying local effusions which so often remain after an attack of gout may be palliated by hot thermal baths, hot mud packs or hot sulphur baths. Where gouty nodules, ankyloses, and other disorders of locomotion result, hot baths and hot mud packs offer some relief. A moderately mineralized sodic and calcic bicarbonated alkaline water may be ingested for many months without any untoward alkaline dyscrasia, and with a continued improvement due to the elimination of the *materies morbi* of this disease. (Radio-active therapy page 92.)

**Rachitis.**—Rachitis is a disease of infancy and early childhood due to disturbed nutrition and to metabolic disorders of unknown etiology, leading to visceral changes in the musculature, in the tendons, and also to characteristic skeletal changes in early life. A poorly balanced diet, bad hygienic conditions, including impure air and lack of sunlight, are important factors. Deficiency of the lime salts in the dietary is always present, indicated by the appearance of retarded dentition, bowing of the long bones, greenstick fracture, etc. The crounotherapeutic measures advocated for the relief of rickets are practically the same as those recommended for the care of scrofulosis. The earthy mineral waters containing calcium and magnesium salts are indicated. These salts, carried in solution in such waters, when prescribed in this disease, will aid in supplying the deficiency of bone-producing salts, will correct the intestinal catarrh, accompanied with increased acidity of the secretions, and with diarrhea most always observed in rachitic youngsters. Its continued administration will bring about conditions leading to the restoration of normal assimilation of the lime salts and normal nutrition. A water, rich in bicarbonates of calcium and iron is particularly indicated in this type of disease, such a water carrying 60 to 65 parts per 1,000,000 of the bicarbonate of iron, should be given a child in doses of 1 liter per day.

**Rheumatism.**—The tendency today is to apply the name gout only to diseased processes dependent upon abnormalities of the metabolism of purins, and to use the term *arthritis* to designate inflammatory trouble within a joint, regardless of the etiology, and to use the word *rheumatism* (if we continue its use at all) for that group of chronic inflammatory joint disturbances produced by the *virus*, which is the etiological factor of acute rheumatic fever.[1] There is but little question that many joint disturbances are given the appellation "rheumatism" when, in reality, the disease should be called by a different name.

*Chronic Rheumatic Affections.*—Whether involving the muscles, the fascia, the periosteum, the synovial capsule and ligamentous structures, will be ameliorated by the action of the hot-peat baths and hot-mud baths. These baths contain in great abundance, salts, gases and mineral matter, which exert irritant action on the cutaneous surface, and, together with friction and pressure induced by massage, favor, to a surprising degree, the absorption of fluid effusions and retrogressive

[1] Rheumatism is an infectious disease caused by Poynton's *Micrococcus Rheumaticus* which enters the blood through the portal of the tonsil,

metamorphosis of inflammatory products. These baths are administered at high temperatures, much higher than the mineral-water bath, and the heat in this type of bath neutralizes the increased sensitiveness and irritability of the diseased part, thereby exerting a favorable influence upon anatomical changes and absorption of effusion. This type of bath also stimulates metabolism, increases secretory action of the skin, induces favorable changes in the affected parts through dilatation of the vessels and, by influencing favorable circulation, irrigates the tissues. They exert a useful influence in rheumatic palsy, as they aid in restoring nerve conditions deranged by the presence of exudates, and in obstinate cases prevents the tendency to atrophy in paralyzed muscles. In all these "rheumatic" conditions the "drinking cure" of calcic bicarbonated and sulphated alkaline waters should be continued in sufficient amounts to keep all the secretions alkaline.

*Rheumatic Ankylosis.*—A course of hot-peat baths and hot-mud baths in connection with the "drinking cure" is useful and has the highest reputation in the palliative treatment of this condition.

*Chronic Articular Rheumatism.*—In chronic articular rheumatism complicated with valvular disease the thermal brine baths of Nauheim and Kissengen deserve the preference.

*Obstinate Subacute Rheumatic Disorders.*—In obstinate subacute rheumatic disorders of long standing, particularly of the joints, vigorous stimulation by the use of thermal sulphurous baths should be ordered, and the highest possible temperature that can be borne by the patient should be used, and the cutaneous hyperemia induced by the bath should be continued by warm blankets carefully tucked around the patient when placed in bed. In addition to the thermal baths, Russian steam baths, Irish-Roman baths, electric-light baths—all render good service in recent attacks of muscular rheumatism. The drinking cure is not to be overlooked; a calcic bicarbonated sulphated alkaline water is advised.

*Rheumatoid Arthritis.*—Rheumatoid arthritis or osteoarthritis is included in this grouping, not because we think its relation to rheumatism a close one, but because the impression is widely extant that it is intimately related to rheumatism and gout. In the light of our present knowledge, however, we do not think its closest pathological affinities are intimately related with either, and we question its general use and believe it is frequently wrongly applied to some forms of chronic articular gout and rheumatism, and suggestions for treatment are often untrustworthy. The treatment of this particular diseased entity by mineral waters is one presenting some difficulty, and the consensus of opinion of authorities as to the value of such treatment is divided. One school holds that the disease is of microbic infection, having no relationship with rheumatism, and maintains, rightly so, that the proper method of treatment is a tonic and supporting one, and that a change to a high altitude with a dry, bracing climate, cheerful and

hygienic surroundings, is of great importance, and the most serviceable course to pursue. Another school of practitioners hold to the opposite opinion, classing the malady with rheumatism, advising spa and mineral-water treatment.

## DISEASES OF THE ALIMENTARY TRACT AND LIVER.

**Chronic Catarrh of the Stomach.**—Chronic catarrh of the stomach is an inflammation of the mucosa, characterized by marked increase of mucus, changes in the gastric juice, and in advanced cases hypertrophy of the muscular coat, increased thickening and proliferative changes in the mucosa, atrophy of the gastric follicles and marked proliferation of the submucous tissue. There are two forms of this disease: (*a*) Primary and (*b*) Secondary.

(*a*) The *primary form of gastric catarrh* is usually due to the patient disregarding the orthodox conventions of eating. Alcohol, excessive eating and drinking are the chief etiological factors. Poisons, irritants, improperly prepared food, faulty mastication, eating too rapidly and irregularly are sufficient to start and continue primary chronic gastric catarrh.

(*b*) *Secondary gastric catarrh* is dependent upon primary organic disturbance of the stomach, cancer, pyloric obstruction and dilatation, long-continued atony of the stomach wall and circulatory faults, causing chronic enlargement of the mucosa. In chronic gastritis there is usually subacidity. The predominating symptoms are excessive production and vomiting of mucus, anorexia, pyrosis, epigastric pain, irregular bowels and coated tongue.

The crounotherapeutic indications for the treatment of this disease when of long standing, with an abundance of mucous atony and torpor of the musculature of the stomach, diminished reflex, irritability of its mucous lining, stasis of the stomach contents and more particularly of cases of chronic gastric catarrh, of gourmands and tipplers, and in gastric conditions arising from sedentary occupations, the cold sodic and magnesic sulphated saline waters are indicated and their use advised. For the ordinary *gastric dyspepsia* with acid eructation, pyrosis, fulness after meals, and general enfeebled digestion, the water *par excellence* are those plentifully impregnated with the alkaline bicarbonate of sodium and magnesium, with an abundance of carbonic acid. If the condition should be accompanied by a tendency to diarrhea, a water containing the bicarbonate of calcium is indicated, and should be given soon after meals; and they seem to act more efficaciously if taken warm. To obtain the best results an examination of the stomach contents will reveal whether the condition is due to hyperchlorhydria an excess of hydrochloric acid in the gastric juice or to hypochlorhydria—a deficiency of that acid. If the former condition prevails a sodic, magnesic, calcic, bicarbonated, alkaline water

is indicated to neutralize the acidity. If the latter condition is shown a sodic, potassic, muriated, alkaline-saline water is advised to stimulate gastric function. In outlining a course of treatment the "drinking cure" is only a part of the plan calculated to benefit dyspeptics. Change of climate and habits of life, release from work, home, or business perplexities, and inducements to exercise in the open air, the regulation of the dietary, with constant medical supervision, the toning effect of the waters, as well as the soothing influences of the baths and douches, all of which influences are adjuvants which tend to the restoration of gastric tone and healthy functions.

**Chronic Intestinal Catarrh.**—Chronic intestinal catarrh may arise from an acute enteritis which shows no tendency to recovery, and more frequently from repeated attacks of acute catarrh, which follow at short intervals. Patients are prone to disregard advice and the prescribed dietary and, as a result, the condition becomes chronic. There is hyperemia and swelling of the mucous membrane, with increased secretion of mucus. The predominating symptoms are bloating, passage of flatus, eructation of gas, colicky pains, lassitude, anorexia, nausea, loss in weight, anemia, slow pulse and cold extremities. The dietary should be supervised, and the sodic, sulphated, alkaline-saline, mineral waters prescribed. This type of water will liquefy the mucus, increase intestinal activity and stimulate bowel action, assist in the evacuation of toxins and poisons and aid metabolism. Hot baths, preferably the Nauheim baths at 41.1° C. (106° F.) from eight to ten minutes' duration, every other day for two weeks, have proved beneficial.

For chronic intestinal catarrh associated with atony of the bowel, habitual constipation, and hemorrhoidal tendencies, with inefficient hepatic function, highly mineralized, cold, sodic, muriated and sulphated waters are indicated. In many dyspeptics the foregoing symptomatic conditions are liable to coexist, and fortunately we are abundantly supplied with a variety of suitable mineral waters, in which the chemical constituents are particularly adapted to the various associated symptoms. The difficulty in determining, with precision, the true nature of the intestinal disorder, imparts an element of more or less uncertainty in the prognosis, and the results to be obtained from the particular course of treatment outlined.

**Chronic Constipation.**—Chronic constipation may be caused by hyperchlorhydria, ulcer, cancer, dilatation, simple atony, catarrhal conditions, and achylia gastrica, obstruction by tumors of the intestine, or tumors pressing on the bowel from some adjacent organ, by stricture within the intestine, by external stricture, such as peritoneal adhesions, and by chronic intussusception. Chronic constipation may result from disturbances of the motor function, and may also be caused by atony of the bowel. Repeated neglect to obey the call of Nature is also a frequent cause, sedentary life and depressing emotions are also causative actors. The correction of the dietary, regulated exercise and

the administration of one of the sulphated, sodic, magnesic, saline waters, two glasses on arising and repeated three or more times during the day will usually relieve the condition. The sulphate ions in the natural mineral water liquefy the intestinal secretion, stimulate hepatic function and increase the motor activity of the intestinal musculature, leading to free evacuation of bowel contents.

Constipation is often associated with gastric disorders, especially with gastro-intestinal catarrh, and in handling these cases successfully we have to adopt such measures as will overcome the constipation while alleviating the gastric condition. Constipation may, however, exist without any notable dyspeptic symptoms—when one of the sodic, magnesic, muriated and sulphated saline waters will be indicated. The presence of sodium chloride with the alkaline carbonates in a water impregnated with natural carbonic-acid gas lends efficiency to the potency of the water. In persons advanced in life, and in stout women of sedentary habits, the constipation is often due to muscular torpor of the large intestine. In this type of cases abdominal massage, combined with a course of saline laxative waters proves of great value. Fortunately we have in this country a great variety of this special class of mineral waters in almost any section of the United States. Such waters need not be highly mineralized, and it is surprising how slight a proportion of saline ingredients will produce aperient action. Such waters should be taken cold immediately on arising, and the quantity regulated in accordance with the degree of the concentration of the predominating chemical constituents.

**Chronic Intestinal Stasis.**—Chronic intestinal stasis is our old friend "chronic constipation" with a new name, of which the causes are legion. Lane and his followers consider mechanical obstructions, "special kinks," as the chief factors in the production of intestinal stasis. Lane holds that chronic intestinal stasis is a delay in the passage of the contents of the intestinal canal, of sufficient duration as to result in the production in the small intestine, especially of an excess of toxic material, and the absorption into the circulation of a greater quantity of poisonous products than the organs, which convert and excrete them, can handle. Contrary to Lane's definition of this malady, it is known that the contents of the small intestine are liquid, and marked narrowing is necessary to impede the too rapid passage of the contents. Otherwise why did Nature put the ileocecal valve at the junction of the small and large intestine? Moreover, the motility of the small intestine *is rapid*, which makes stasis still less likely to occur. On the other hand, the motility of the large intestine is slow, the contents are of a solid consistency, and stasis from "kinks" or adhesions results easily. Lane advocates surgical measures to relieve the "kinks" and cure the stasis, but I prefer to save the patient the ordeal of an operation by prescribing a suitable dietary and the administration of Russian mineral oil, followed by the ingestion of a sodic, magnesic, muriated, sulphated, saline water, to liquefy

the intestinal mucus and fecal contents and to stimulate the motor function of the bowel and to aid the evacuation of the fecal contents.

**Autointoxication.**—Autointoxication is a term that covers a multitude of sins in *diagnosis*. It is a condition brought about by continued excesses of indulgence at the dinner table and undue indulgence in malt liquors, combined with sedentary life and with inefficient hepatic function and portal obstruction. The liver is enlarged, its lower border projecting below the ribs, there is catarrh of the bile ducts, the portal circulation is sluggish and hemorrhoids are present. The complexion will present a muddy appearance, with the conjunctiva tinged yellow, the tongue coated, bowels constipated, drowsiness after meals, with dizziness and vertigo in the corpulent individual. The first step in this class of cases is to regulate the dietary and to supervise forms of physical exercises for the patient, both passive and active. The second step will be the selection of the proper mineral water, which is of the utmost importance, and must indeed supersede other methods of treatment. The class of waters *par excellence* in these cases is the "bitter waters" containing the alkaline sulphates and the chloride of sodium and saline sulphuretted waters. These waters, owing to the sulphate ions in solution, exert double action by stimulating the processes of endosmosis and exosmosis, promote the liquification of and stimulate the flow of the bile. They also stimulate peristaltic action of the muscular coats of the bowel, increase the flow of intestinal secretions and expedite the expulsion of intestinal waste. A considerable period of rest at a quiet restful resort should follow all prolonged "drinking cures" of the very highly mineralized, purgative waters.

**Chronic Diarrhea.**—Neglected or severe acute catarrhal enteritis may occasionally lead to the chronic changes in the intestinal mucosa and mesenteric glands. These changes may be atrophic, or there may be cystic degeneration of the intestinal follicles. Chronic hyperemia of the intestinal mucosa, dependent upon circulatory or respiratory disease, may cause chronic diarrhea. Intestinal dyspepsia resulting from fermentation, if not corrected by proper dietary, will lead to chronic diarrhea. Chronic enteritis may result from previous typhoid infections, from dysentery, chronic malaria, and any disease which causes atrophic changes in the intestines.

In the treatment of chronic diarrhea in emaciated, enfeebled individuals, especially if intestinal catarrh complicates the situation, the thermal, sodic, muriated and sulphated waters, drunk in small quantities, acts favorably upon the diarrhea, as well as upon the diarrhea caused by an excess of bile, or qualitatively altered secretion of this fluid. It has long been the practice of Virginia physicians to prescribe alum waters in diarrhea of long standing. These aluminic, ferruginous, sulphated acid waters exert a very pleasant astringent action in this type of cases. No doubt, though, the stronger calcic, sulphated, alkaline waters are more generally used than others in

conditions marked by liquid evacuations. A few weeks stay at one of the *calcic* spring resorts often proves successful in the most obstinate cases where Galenical medication has failed.

**Chronic Diarrhea.**—Scrofulous and rachitic individuals are best treated with calcic; sulphated, alkaline waters containing the sulphate of iron or the sulphate of iron and arsenic, but these waters can only be drunk for a short time and in small quantities, on account of the possibility of disturbance to gastric digestion.

## DISEASES OF THE LIVER.

**Chronic Hyperemia.**—Chronic hyperemia, or congestion of the liver, whether due to overeating, alcoholism, insufficient exercise or stasis in the portal circulation, sedentary occupation, habitual constipation, or induced by disease of the heart, the lungs, the spleen or the uterus, is especially amenable to mineral-water treatment. The waters which are found most useful in the treatment of this condition are the warm sodic, sulphated, alkaline waters; or the same waters cold in the obese, vigorous patient with constipation. In thin and feeble persons with congestion of the liver the simple alkaline waters are also very useful. In the less vigorous, alcoholic and gouty patients, more particularly if there is a tendency to diarrhea rather than to constipation, the alkaline, bicarbonated, calcic waters give good results.

**Jaundice.**—Jaundice is due to a clogging of the bile ducts or to obstruction to the large extrahepatic bile vessels (ductus choledochus) or the small intrahepatic vessels (bile capillaries). The prominent symptom is a yellowish staining of the skin and clayey-whitish stools with bile in the urine. The bile pigments formed by the liver cells pass over into the blood through the lymphatics as a result of obstruction to the bile passages.

*Obstructive Jaundice.*—Obstructive jaundice results from obstruction to the normal flow of the biliary secretion. The obstruction may be partial or complete. In complete obstruction no hydrobilirubin will be formed in the intestine and urobilin will disappear from the urine, while bilirubin will be present in the urine. Sodic, muriated, and sulphated, magnesic waters stimulate the hepatic function and are indicated in this condition.

*Catarrhal Jaundice.*—Catarrhal jaundice is due to swelling and obstruction to the terminal portion of the common duct. Catarrhal inflammation of the bile ducts is usually associated with gall-stone formation. The mucous membrane is swollen and a plug of inspissated mucus fills the narrow portion just at the orifice, completely obstructing the outflow of bile. The symptoms are easily recognized. The diagnosis is rarely difficult. This disease is of short duration, and readily yields to the administration of the alkaline bicarbonated waters. If the condition is of long standing, and accompanied by gall-

stone formation, the potassic, sodic sulphated, and muriated, saline waters will better serve the purpose.

**Cholelithiasis.**—No chapter in the domain of medicine is more interesting than that which deals with the formation of gall-stones. Gall-stones are biliary calculi that form in the biliary tract, usually in the gall-bladder. They are more common in women than in men. Among the predisposing factors are the sedentary habits of women, repeated pregnancies, puerperal infections, and in days gone by "tight lacing" was accredited as a causative factor, but today women wear less clothes than men and corsets are "taboo." Additional causative factors may be mentioned, viz: chronic cardiac disease, pulmonary disease, chronic diseases of the gastro-intestinal tract, dietary indiscretions and abuse of alcohol. The composition of the gall-stone varies. They may be: (*a*) pure cholesterin; (*b*) laminated cholesterin with lime salts; (*c*) mixed cholesterin stones; (*d*) mixed bilirubin-calcium stones; (*e*) pure bilirubin-calcium stones (always small). The leading symptoms associated with gall-stone are pain, often so severe that it has been termed "gall-stone colic." If there is an impacted gall-stone in the common duct jaundice will be a prominent symptom. Attacks of biliary colic require morphine hypodermatically. The after-treatment may be judiciously directed by the administration of laxative, cold, sodic, magnesic, sulphated, muriated, alkaline-saline waters to stimulate the hepatic function and to excite the reflex action of the gall-bladder and ducts. This should be followed by the copious drinking of the alkaline, calcic, sulphated and bicarbonated waters. The dietary should be properly supervised. It is an unsettled point whether the efficacy of the "drinking cure" depends solely upon the formation of a large quantity of liquid bile, or whether the excessive amount of water renders the bile so strongly alkaline that its solvent action disintegrates the stone. One author has aptly said: "We do not delay prescribing this treatment until the mode of action is physiologically explained, but order the treatment and cure the patient." The indication of first importance in this class of cases is the dilution of the bile, so as to promote its free flow through the bile ducts. The warm alkaline sodic sulphated waters stand first in repute for this purpose, and the warm simple alkaline waters are of almost equal importance. These mineral waters may be drunk at the patient's home, or he may more effectively partake of them at the spring, for a period of from four to six weeks. In order to prevent a recurrence or return of the malady the patient should take the "drinking cure" once a year for the next two or three years. Warm baths in the same waters as are used in the "drinking cure" are advised.

**Splenic Enlargements.**—Splenic enlargement resulting from chronic malarial infection, as well as from hypostatic enlargement of the organ, dependent upon disturbance of the circulation or digestive disorders, responds favorably to drinking cures with the sodium sulph-

ated saline waters. The after-treatment includes the use of ferruginous bicarbonated water to improve the disturbed hemogenesis. The most efficient adjuvant to bring about reduction in the size of the organ and to improve the anemic and the leukemic state of the circulation is the use of peat baths containing great quantities of ferrous sulphate. If the splenic enlargement is a manifestation of specific disease, tertiary syphilis, the sulphurous waters containing iodine as a "drinking cure" and baths in the thermal sulphur waters are indicated. Rachitic persons are favorably influenced by a drinking cure of the bitter waters carrying sodium and magnesium sulphate and sodium chloride.

## DISEASES OF THE GENITO-URINARY SYSTEM.

**Albuminuria.**—Albuminuria is the presence of serum albumin in the urine. There is always present serum globulin, which is of little prognostic significance in most cases. Formerly the presence of albumin in the urine, as voided, was regarded as indicative of Bright's disease, but now it is recognized as occurring under many circumstances without the existence of organic change in the kidney. The normal blood constituents, serum albumin and serum globulin, escape from the circulation into the renal tubules. This leakage of albumin indicates either transient and slight, or a permanent and grave degeneration of the epithelium lining, the glomeruli or the epithelium of the uriniferous tubules. For all practical purposes it will be sufficient to recognize only two types of this disorder—*true* albuminuria and *false* albuminuria.

*True Albuminuria.*—True albuminuria may be either: (1) A hematogenous type due to alterations in the diffusibility of the blood, especially the blood albuminoids, owing to changes in the salts of the blood or the alkalinity of the serum; (2) a parenchymatous type due to changes in the glomerular and tubular apparatus of the kidney; (3) a vascular type due to changes in the walls of the renal vessels, which may be affected by toxic agents, inflammatory conditions, vasomotor changes or altered blood-pressure.

*False Albuminuria.*—False albuminuria is a condition where the albumin finds entrance to the urine outside the tubular structure of the kidney. It may, therefore, be termed of extrarenal origin. The albumin escapes from some portion of the genito-urinary tract, from the kidney pelvis, to the meatus urinaris. The majority of such albuminurias are surgical, due to stone, bladder and ureteral lesions, including cystitis, gonorrhea, leucorrhea, etc.

When the kidneys allow a leakage of albumin from the blood stream into the urine there is a beginning degenerative change with more or less kidney irritation. A mild alkaline, bicarbonated water, possessing diuretic and antacid properties, will allay irritation and overcome acidity, and when the presence of albumin is detected in the urine,

whether a slight trace or more; one of the calcic, sodic, bicarbonated, sulphated alkaline waters should be ordered, in doses of at least 2 or 3 liters daily. I have, time and time again, had the gratification of seeing the albumin disappear and the casts vanish within ten days. When the urine is scanty and high colored, or when it is acid in reaction, one of the alkaline, sodic or calcic, bicarbonated waters may be administered in liberal quantities with undoubted advantage and with entire safety. The urine within twenty-four hours usually is increased in amount, clears up and becomes alkaline in reaction. In the treatment of chronic nephritis these waters exert a happy effect upon the symptoms, as they overcome digestive disturbances, aid the process of assimilation and favor normal metabolism. "Drinking cures" with this class of waters, together with water containing the bicarbonate of iron, for home consumption as an after-treatment is advised. If the patient is greatly debilitated, and the percentage of albumin is high, if nephritic asthma is frequent, and the development of anasarca is marked, the systematic use of mineral water will not offer much hope, but, on the contrary, might be injurious and possibly hasten the process of dissolution. Since some of these mineral waters contain sufficient mineral ingredients to make them active renal stimulants, the physician must use the same discrimination as in the case of prescribing diuretics obtained from the apothecary. In the early stage of gouty kidney, with slight albuminuria, mineral-water treatment directed to the relief of the gouty state may be of service and, by correcting the gouty condition, may cause the albumin to disappear. But this line of treatment must be directed with care, and we must be sure that the water ingested is freely excreted by the kidneys, for, if this is not done, there will be danger of increasing blood-pressure, which we should be careful to avoid in this type of cases, in the majority of which arteriosclerosis is often present and most always impending.

In chronic disease of the kidneys *warm baths* exert decided sedative and anodyne action, especially when prolonged. In a condition accompanied by great irritability of the vesical mucous membrane with dysuria, bathing with some of the natural thermal waters is useful. In chronic nephritis hot baths, 34° to 40° C. (94° to 104° F.) may be administered with comfort and benefit.

**Casts.**—Casts are not always a pathognomonic symptom of true nephritis, and are frequently found to be transitory and of no pathological importance. Casts are moulds of the renal tubules and, when persistently present, are as a rule conclusive evidence of renal disease.

*Granular Casts.*—Granular casts are degenerated, epithelial casts. They are formed in the tubule or, at times, in the pelvis of the kidney, and are indicative of more or less irritation of the kidney substance.

*Epithelial Casts.*—Epithelial casts are indicative of acute tubule nephritis, and are positive evidence of tubular involvement.

*Hyaline Casts.*—Hyaline casts may occasionally be found in the urine of normal subjects. Persistent albuminuria with hyaline casts

and an occasional granular cast is the danger signal of nephritis. When the analysis shows the presence of a trace or more of albumin with casts, granular, epithelial or hyaline, do not wait longer, but order your patient on one of the calcic, sulphated and sodic, bicarbonated, alkaline (lithic) waters and direct the copious use of the same to allay kidney irritation, to overcome acidity and to aid metabolism.

**Chronic Vesical Catarrh.**—Chronic vesical catarrh, or catarrhal cystitis, is an irritable condition of the bladder, due to some form of infection. Pain is always present, usually worse when the bladder is full or completely empty. There is great frequency of urination, only a few drops being voided at a time, which is concentrated, highly acid and highly colored. The walls of the bladder are hyperemic, the epithelium is swollen and tender and coated with a more or less tenacious mucus, rich in pus cells and discarded epithelia. There may, or may not, be hemorrhagic spots. The chief indication is to administer a mild diuretic and antacid water to neutralize the acidity and ally the irritation. An alkaline, sodic, calcic, bicarbonated water drunk copiously will soon relieve the distressing symptoms.

This disorder yields readily to the "drinking cures" of the alkaline, bicarbonated water carrying sodium, magnesium and calcium in solution. The long-continued and liberal use of these waters permits the entrance of sodium bicarbonate into the blood stream, renders the urine alkaline, allays vesical irritation, liquefies the mucus present and favorably tones the delicate mucous membrane of the bladder. In chronic catarrhal conditions of the bladder and the pelvis of the kidney following specific urethritis, and in catarrh of the bladder in aged persons, as well as catarrhal irritation due to urinary calculi, "drinking cures" with the alkaline, thermal, sodic, bicarbonated waters and with the alkaline-saline, thermal, sodic, sulphated and muriated waters render good service. The vesical catarrh in gourmets and all heavy eaters from consuming inordinate quantities of highly seasoned foods, and in drinkers who imbibe too freely of irritating hard liquors; those depending upon stasis and circulatory disturbances are benefited by a course on the sodium chloride waters. In all chronic catarrhal conditions of the bladder and the pelvis of the kidney with profuse secretion of mucus, following chronic specific urethritis, or due to enlargement of prostate gland, the calcic, bicarbonated waters freely administered are especially indicated. The higher the percentage of free carbon dioxide in these earthy calcareous waters the better. Patients, after repeated attacks of nephritic colic, frequently come to the springs on advice of their surgeon, with his admonition "go to the springs and pass your stone." I had the good fortune last summer to see one man pass thirteen small concretions after a ten days "drinking cure"; on a calcic, sodic, bicarbonated, alkaline (lithic) water, carbon-dioxated. These waters have a very potent disintegrating effect upon uric-acid gravel and calculi, and are the chief reliance in phosphatic calculi. Even in the presence of vesical calculi of large

size, where surgical intervention is necessary, these waters are useful as an after-treatment to wash away the remaining sediment and to neutralize the uric-acid diathesis in general. The dosage is regulated in accordance with the exigencies of each individual case, usually 2 or more liters daily. Neither the alkaline nor the earthy calcareous waters should be prescribed in cases of phosphatic concretions, but waters rich in free carbon dioxide and containing only nominal quantities of sodium bicarbonate should be used. It is always important to remember that the amount of urine excreted must be almost equal to the amount of water ingested.

**Nephrolithiasis—Renal Calculi (Stone in the Kidney).**—Much research has been done to determine the cause of stone formation in the pelvis of the kidney, but still the exact pathogenesis is far from clear. The existence of many urinary solids in saturated solution, owing to the colloidal state, the influence of local irritations and the presence of foreign bodies, such as bacteria, or degenerated epithelial elements, are believed by Barker to be important causative factors. Concretions may result from defective elimination of organic nitrogenized substances from the system. The concretions vary in size from gritty particles (renal sand) to very large calculi, sometimes filling the whole pelvis of the kidney and even branching into the calices, thus forming a cast of the renal pelvis in its entirety. Renal calculi may consist of: (*a*) Uric acid and urates; (*b*) oxalic acid, calcium oxalate; (*c*) phosphates; (*d*) of the rarer constituents of the urine, cystine and xanthin, and finally stones may form from the carbonate of calcium. Calculi are formed primarily in the kidney from whence they may pass down through the ureter into the bladder. However, the stone is frequently lodged in some portion of the ureter, producing an attack of renal colic. The pain is atrocious, the most excruciating, tormenting, nerve-racking known to civilized man, and only relieved by $\frac{1}{4}$ gr. of morphine sulphate administered hypodermically.

**Uric-acid Calculi.**—Uric-acid calculi from the deposition of uric acid and urates in the urine, are closely allied to the gouty state and arise usually from the same cause—overeating and drinking, too much highly seasoned food and too large quantities of alcoholic beverages. This condition is greatly benefited by the copious administration of calcic, sodic, lithic, bicarbonated, alkaline waters. Such waters neutralize the acidity, increase metabolism and, through its solvent action, disintegrate the concretion.

**Oxalic-acid Concretions.**—Oxalic-acid concretions are termed acid gravel. This is a disordered metabolic disturbance where the quantity of oxalates excreted is only one factor to be considered. The other, and perhaps the more important factor, is where the urine loses the power to hold the otherwise insoluble calcium oxalate in solution. The solubility of the latter salt depends upon the acid phosphates, and especially upon the magnesium salts present in the urine and, naturally, to some extent also upon the amount of calcium salt excreted

by the urine. This condition is amenable to crounotherapeutic measures: (1) Restrict the oxalate-bearing foods from the dietary; (2) administer freely mineral waters in which the magnesium salts predominate and administer the acid phosphates in addition. This régime will prevent the formation of calcium oxalate concretions, and the solvent and antacid properties of the water will disintegrate the calculi, allay irritation and greatly ameliorate the condition of the patient.

**Phosphatic Calculi.**—Phosphatic calculi consisting of calcium phosphate, are apt to occur in the overworked student or business man leading a too sedentary life with lack of exercise. If the calcium carbonate is present with the phosphate of calcium, the abundant use of alkaline mineral waters, containing a large amount of carbon dioxide and but little sodium, is indicated. The sodic, muriated, alkaline-saline waters exert harmful effects in this type of calculi. It is held that the carbonated acidulous waters may, due to the carbon dioxide present, increase the acidity of the urine, limit the growth of calcium stone and possibly constitute a solvent for small phosphatic calculi. The chemical character of a calculus may be determined from a microscopic examination of the urinary deposits. Occasionally a stone will be found containing all the different elements composing the single calculus. The action of the calcic, bicarbonated, carbon-dioxated waters are produced in different ways: (*a*) They aid in overcoming the constitutional metabolic fault, which gives rise to the formation of these calculi; (*b*) through their diuretic and diluent action they exert a palliative effect upon catarrhal inflammation; (*c*) they are believed to possess solvent antlithic properties, favoring the breaking-down of the stone and the chemical disintegration and the solution of the calculi, thus favoring their speedy expulsion with the urine.

**Vesical Calculi.**—Vesical calculi arise primarily through crystallization from the urine of urates, or oxalates, that have not undergone decomposition. Vesical calculi are most always formed in the kidney and pass down the ureter into the bladder to become vesical calculi, where they may enlarge by concentric concretion and deposition of lime salts. These calculi are caused by the same constitutional metabolic vice as the renal calculi, and the mineral-water treatment for the former condition applies here with equal efficiency.

**Chronic Nephritis.**—Chronic nephritis, chronic Bright's disease, is a progressive disease of the kidney, in which the organ is at first enlarged with a chronic diffused hyperplasia, involving the epithelium of the glomeruli, and the interstitial tissue—a grave condition—offering little hope for restoration to health. Destroyed kidney tissue can never be regenerated, new tubules are never found, nor new glomerules reformed after their destruction. With the destructive changes in the kidney, both glomerules and tubules undergo compensatory hypertrophy. These changes are Nature's aid which make it possible for the kidney, when not too extensively diseased, to "carry on," performing sufficient

function to maintain life for long periods. Barker, Bradford and others contend that man can easily spare two-thirds, or even more, of the kidney substance without serious inconvenience. The disease is insidious, creeping upon one like a "thief in the night." Often no subjective or objective symptoms are present.

These cases are helped by mineral-water treatment; a mild, calcic, sodic, bicarbonated, sulphated, alkaline water will overcome acidity, relieve irritation in the kidney substance, stimulate metabolism and ameliorate distressing conditions.

**Dropsy.**—Dropsy is a leading symptom in advanced cases of chronic nephritis, and is never to be lightly considered. It is usually a sign of the terminal stage of the disease. When edema in any form complicates chronic nephritis and, more particularly, if associated with marked cardiac insufficiency and reduced urinary secretions, retained urea, and with fluid accumulations in the serous cavities, the outlook is unfavorable for the prolongation of life. The urine in these cases will be abundant in quantity, with specific gravity at normal or slightly above, with hyaline, granular or epithelial casts present. The amount of albumin may be considerable, but so long as the amount of secreted urine is within normal limits, the number of casts limited and no evidence of advancing kidney degeneration, the prognosis is not so gloomy. The administration of a mild calcic, magnesic, bicarbonated, alkaline waters will be of use, but never give a sodic, muriated water, which would aggravate the dropsical condition (see also section of Chapter IX, on Edema, page 109).

## DISEASES OF THE CIRCULATORY SYSTEM.

Prior to a few decades ago all cardiac diseases were considered as a counter indication for crounotherapeutic and balneotherapeutic measures, but today both "drinking cures" and "bathing cures" are highly recommended for the relief of a number of functional cardiac disturbances, as well as for the treatment of organic disease of the heart. But in former times all valvular cardiac diseases were considered with more serious concern than at present, and it was the practice to give a far graver prognosis of some forms of heart disease than would now be considered justifiable. With a clearer understanding of the pathology and etiology of these types of disease, a more hopeful view of their therapeutic management has gained ground, so that at the present time remedial appliances are now highly valued in cardiac therapeutics, which half a century ago would have been looked upon as dangerous to the patient. To-day spas and mineral springs resorts not only receive cardiac patients for "drinking cures" for the relief of collateral disturbances of health, but many prominent spas are now equipped with *special baths* for the relief of morbid cardiac effects themselves, both functional and organic. Balneotherapy has given relief to so many cardiac sufferers, that the "natural"

baths are now imitated artificially, and are largely and quite successfully applied at various resorts.

We fear, however, that the modern tendency has been too optimistic and, in some instances, patients have been referred unwisely for balneotherapeutic methods and the mechanical treatment associated therewith, and that serious results have attended such indiscriminate practice. Moreover, possibly, and unconsciously, there has developed a tendency in popularizing these new therapeutic measures to find the presence of valvular lesions where none exists. No doubt many neuneurotic individuals have been persuaded to undergo treatment by baths for heart affection which had no existence. In considering the usefulness of the "drinking cure" for the relief of cardiac troubles we will, in the first place, refer to those waters which are not credited with any *special* influence on these maladies, but are administered for their beneficial effect in the palliation of collateral functional disturbances. Among the "drinking cures" for cardiac hypertrophy in "free livers," with threatened arterial changes, and in cases of right-sided hypertrophy and dilatation, associated with emphysema, in which the object is to relieve blood stasis and to stimulate the circulation by unloading the intestinal veins, thereby lessening heart labor, we may profitably prescribe the cold sodium, sulphated, alkaline waters or cold, sodic, muriated, saline waters. The cold waters are preferable because the administration of warm waters excite cardiac action and cause the bloodvessels to become engorged. If the waters contain free, carbon-dioxide gas, allow the same to stand for a while in an open vessel, or pour back and forth from one pitcher to another a few times to allow the carbon-dioxide gas to escape, for fear its action would overstimulate the heart.

In *valvular lesions* presenting symptoms of venous stasis in the abdominal viscera, showing that compensation is in danger, such as gastro-intestinal catarrh, hepatic enlargement, hemorrhoids and menstrual abnormalities, the cold, sodium, sulphated, alkaline waters are indicated, but should be freed from gas as thoroughly as possible.

**High Blood-pressure.**—High blood-pressure accompanied with cardiac excitement and other signs of impending danger, where it is necessary to quickly subdue coexisting signs of portal engorgement, the purgative bitter, sodic, magnesic, sulphated, saline waters are often of great service. The dosage should be regulated according to the patient's physical condition and the degree of concentration of the predominating chemical constituents. In all cases where arteriosclerosis is eminent it is the bounden duty of the physician to actively stimulate hepatic and intestinal elimination and to promote diuresis. For this purpose we combine the bitter waters with the use of the sodic, muriated waters, as in combination they lessen the work of the heart by promoting intestinal activity and free diuresis. As previously cautioned, these waters should be freed from gases, and in mild cases the alkaline water may be continued much longer and

in much larger quantity, one daily dose being quite sufficient. The amount of urine eliminated should be watched to see that it almost equals the amount of water ingested.

**Cardiac Neurosis.**—Cardiac neurosis associated with anemia and chlorosis at the pubescent age may be greatly benefited by a course of the bicarbonated, iron waters, while palpitation, coming on at the climacteric period, or dependent upon intestinal stasis, may be greatly benefited by the use of aperient sodic, sulphated waters.

**Cardiac Palpitation.**—Cardiac palpitation accompanied by exophthalmic goiter is often materially relieved by the use of good chalybeate waters and the administration of glandular therapy. The "bathing cure" in heart disease by means of carbonated baths was popularized by the use of the natural, thermal, gaseous brine baths of Nauheim, which are exceptionally high in free carbon-dioxide gas. The efficacy of the beneficial effects of these gaseous thermal springs in certain cardiac affections is no longer questioned. It has been found by experience that the following types of heart disorders are benefited by balneotherapeutic treatment: (*a*) Dilatation without hypertrophy, and not associated with any cardiac lesion beyond weakness of the heart muscle, brought about by overwork or strenuous physical exertion, as in football players, etc.; (*b*) valvular disorders in the early stages in young persons where compensation has not been firmly established, or where it appears from some cause to be temporarily upset; (*c*) convalescents from attacks of acute rheumatism would do well to have a course of Nauheim baths to prevent the occurrence of valvular lesions. While undergoing this treatment murmurs have been observed to disappear; (*d*) *cardiac neuroses*, particularly in cases of pseudo- or vasomotor angina, due to arterial spasm, found frequently in gouty individuals, are materially helped by the Nauheim treatment, which acts by dilating the superficial arterioles, and thereby lowering blood-pressure.

**Cardiac Diseases.**—Cardiac diseases are not benefited by baths that irritate the skin, that are too high or too low in temperature or that are of too long duration. Therefore, the Turkish-Roman, Russian and electric-light baths are contraindicated.

**Fatty Heart.**—Fatty heart in the obese is a condition amenable to a course of drinking and bathing cures. In such cases, with a feeble cardiac impulse, and a thready pulse, with an enlarged area of cardiac dulness, suspicion of the presence of hypernutrition (Kisch) of the heart is justified, and a systematic "drinking cure" with a cold, sodic, sulphated, saline water is indicated. Such cases, even the severe types, yield to this method of treatment. Careful and discriminating medical supervision of the use of mineral waters in this type of cardiac disorders is advisable, and the treatment should extend over a considerable period of time demanded by this class of patients.

In advanced *fatty degeneration of the myocardium*, with swelling of the extremities due to stasis in the circulation, hydremic conditions,

and general debility, "drinking cures" with muriated waters are inadvisable. In prescribing mineral waters it is always imperative to watch the amount of urine eliminated. This should in all instances equal the quantity of mineral water ingested.

## DISEASES OF THE BLOOD AND BLOOD-MAKING ORGANS.

**Anemia and Chlorosis.**—The ordinary forms of anemia are characterized by a loss in the total volume of the circulating medium, through minute hemorrhage in chronic dysentery or in any condition incident to minute hemorrhage in any part of the body. It may be the result of profuse hemorrhage due to hemoptysis, to a severe wound or to menorrhagia, or the condition may be due to poor food, bad hygiene, previous disease, present illness or protracted and long-delayed convalescence.

**Chlorotic Anemia.**—Chlorotic anemia is a disorder of metabolism frequently found in young girls just budding into womanhood and connected with the development and establishment of the menstrual functions. The pathology of this disorder is not a loss to the volume of the blood stream, but a diminution of the red blood corpuscles or a depreciation of the hemoglobin content of the individual red blood cells. Long experience with this type of cases demonstrates the efficacy of iron in bringing about a restoration of the normal red blood content of these cases. Clinical experience has amply demonstrated the fact that the administration of a properly selected ferruginous preparation will gradually restore the hemoglobin content of the blood stream. The accumulated evidence of the experience of eminent clinicians emphasizes the fact that a mineral water containing an easily assimilable iron, more particularly in the form of the bicarbonate, carrying 60 to 65 mg. per liter, is superior to any of the pharmaceutical preparations of iron obtained from the apothecary. In some types of anemia an iron water, carrying even an infinitesimal quantity of arsenic, will be valuable in disorders characterized by poverty of the blood stream. Hodgkin's disease (thyroid cachexia) will be benefited by iron and arsenic waters, while a muriated saline water will stimulate the activity of the thyroid and the ductless glandular system.

In anemic conditions complicated with chronic intestinal catarrh, persistent diarrhea and malarial cachexia, the sulphated iron waters may be drunk instead of the bicarbonated. Such waters, carrying also the sulphate of aluminum and sodium arsenate, will be admirable agents in the treatment of all depraved conditions of the blood stream.

## INFECTIOUS DISEASES.

**Constitutional Syphilis.**—In days gone by, mineral waters were used with the idea of exerting some specific action on this disease, but today any specific action must be denied. However, "drinking cures"

and "bathing cures" are of some utility in this connection. Their use invigorates the organism in general, improves impaired nutrition dependent upon constitutional disease or from heroic treatments It has been held that their action hastens the appearance of delayed local skin lesions and thereby brings out latent syphilis, verifying the diagnosis in questionable cases. The thermal sulphur waters, used internally as "drinking" and externally as "bathing cures," are the best adjuvants to the specific treatment. These hot-sulphur baths increase the power of the body to absorb the specific treatment, and at the same time the increased temperature of the body augments the action of the specific treatment, and also increases protein metabolism. In aggravated cases of syphilis it often becomes necessary to stop specific treatment; then the "drinking cure" and "bathing cure" with sodium-chloride waters, containing iodine and bromine, may be prescribed with benefit. These waters are useful throughout the entire course of treatment, also for after-cures, following vigorous specific medication used in the tertiary stages of the disease.

## DISEASES OF THE RESPIRATORY SYSTEM.

There are certain diseases of the respiratory organs which promptly respond to treatment by mineral waters, particularly the catarrhal affections of the upper air passages, such as chronic *rhinopharyngitis* and certain forms of *bronchial catarrh* and *pulmonary emphysema* in its early stages. The type of mineral-spring resorts patronized for the relief of these affections are: (*a*) Those with the lightly mineralized, warm, alkaline, sodic, muriated waters; (*b*) those with the moderately mineralized, warm, sodic, muriated, saline waters; and (*c*) those with the warm sulphur springs, preferably containing sodium chloride and hydrogen-sulphide gas. In a few cases the alkaline aperient sodic, sulphated, waters are recommended. In selecting a spa or resort for these chronic respiratory affections, it is of decided advantage to choose one with suitable climatic surroundings, and where the convenience of inhalatory methods of treatment are available.

**Chronic Rhinopharyngitis, Chronic Pharyngitis, Chronic Laryngitis.**— These are all amenable to the same form of mineral-water treatment. A mild and moist climate at the health resort selected exerts a favorable influence upon the successful treatment of this class of cases. The efficiency of inhalation treatment at some of the resorts, where especially fitted inhaloriums are provided, is a contributory adjuvant to the "drinking cure." This form of treatment softens and fluidifies the adherent mucus and soothes the irritated mucous membrane, and may possibly aid in destroying bacterial activity. The classes of mineral waters most frequently prescribed in these cases are the alkaline, sodic, sulphur waters. They stimulate the secretion of mucus and it is thought they act best when taken warm. Applied locally as

a spray or douche, they favor expectoration by their solvent action on the mucus.

**Chronic Bronchial Catarrh.**—Chronic bronchial catarrh in scrofulous individuals and in gouty subjects, complicated with syphilis, the sulphurous, sodic, muriated waters are the first choice, although the alkaline, chalybeate, bicarbonated waters are useful in chronic bronchial pulmonary affections.

**Chronic Emphysema.**—The foregoing remarks on chronic bronchial catarrh, referring to the crounotherapeutic treatment of that disease, are also applicable in this distressing type of disorder. The alkaline, muriated, acidulous waters are recommended, the latter preferably at resorts of high altitude or those situated between 750 and 1000 feet above sea level, surrounded by extensive pine forests.

## DISEASES OF THE NERVOUS SYSTEM.

There are many disorders of the nervous system in which mineral-water treatment and baths are of no avail; there are others in which bath treatment is permissible but not very hopeful, and still a few others where treatments with natural thermal baths are very serviceable. In the majority of these cases reliance is placed almost wholly upon balneotherapeutic methods and not upon the "drinking cure." There is little doubt that much of the benefit derived at the spas to which this class resort is obtained through physiotherapeutic methods, electrotherapeutic appliances, Zander method of exercise, heliotherapy, thermotherapy and dietotherapy, etc.

**Chronic Hyperemia of the Brain.**—This type of ailment presents indications for the depletion of the cerebral vessels, through the production of watery movements of the bowels, which may be accomplished by a "drinking cure" with the cold sodium sulphate and sodium-chloride waters. Their employment systematically and for prolonged periods is a preventive against cerebral hemorrhage in phlethoric obese individuals.

**Neuritis and Sciatica.**—Neuritis and sciatica, peripheral and multiple, due to alcoholic, metabolic or other intoxication; to exposure to cold, or to injury, may be benefited by a suitable thermal treatment. The simple thermal baths afford sedative treatment; warm sulphate baths favor stimulation; in obstinate neuritis and sciatica hot-peat baths, sulphurous thermal baths and hot-mud baths are useful.

**Functional Nervous Disorders.**—Functional nervous disorders, such as headache, neuralgia, neurasthenia and hypochondriasis, are amenable to the "drinking cures." Most of these conditions are merely symptomatic, and their rational treatment depends upon the underlying pathology to which they owe their origin. Insomnia, headache and hypochondriasis may be due to business perplexities, overwork, anxiety, etc., which will disappear on a few weeks' vacation at a

suitable quiet, restful resort. The cause of these nervous manifestations we must seek out and alleviate. If an habitual sick headache is associated with dyspeptic symptoms, constipation or hepatic congestion we may cure the condition and prevent its recurrence by means of the alkaline, bicarbonated, or sulphated saline waters. If neuralgia persists in the anemic, or if complicated with cardiac palpitation, a bicarbonated iron water will give pleasing results.

**Chronic Neuralgias.**—Chronic neuralgias, caused by toxic conditions, constitutional states, or by inflammation of the great nerve sheaths, are frequently benefited by thermal baths. Physiotherapy, especially static electricity, as an adjuvant, is helpful treatment.

**Paralysis.**—Paralysis following exhausting disease, such as typhoid, the acute exanthemata, diphtheria and puerperal fevers, etc., is benefited by "drinking and bathing cures" with the iron waters, which improve the nutrition.

**Americanitis Neurasthenia.**—Americanitis, neurasthenia (psychasthenia or nerve fatigue) is a functional neurosis affecting a large class, whose numbers are legion and increasing daily under the stress and strain of present modes of life in metropolitan centers. Want of proper sleep, lack of a well-balanced dietary, irregular habits and poor hygiene are contributing causes. The term neurasthenia covers a multitude of diagnostic sins, and may be a general expression of derangement of the entire nervous system, or local, and limited to certain organs. Hence the terms, cerebral, cardiac, sexual and gastric neurasthenia. These several types are best handled after ascertaining the pathological factor responsible for the symptoms, prescribing a suitable mineral water resort and ordering the proper balneotherapeutic measures.

**Vagotonia.**—A phase of this disorder of the vegetative nervous system is the spasmodic contraction of the pylorus and sometimes of the esophagus, due to involvement of the pneumogastric nerve. The condition is generally accompanied by hyperacidity and hypersecretion. There is always defective peristalsis, accompanied by flatulence. As a result, elimination is faulty. This condition is aggravated by cold drinks and rapid eating. The treatment should be directed toward correcting the dietary, suitable rest and the employment of a sodic, magnesic, sulphated, saline water taken hot. These waters will stimulate peristaltic activity of the intestinal tract, liquefy mucus and the intestinal contents, thereby favoring elimination of intestinal waste. Hot baths will be of value.

**Sympatheticotonia.**—Sympatheticotonia is a condition of the sympathetic nervous system, in which the symptoms are just the opposite to the symptoms of vagotonia just discussed. Here will be noted dilated pupils, infrequency of winking, dryness of the skin, cold hands and feet, hypoacidity, diminished tone of the intestinal musculature, constipation, tachycardia, high blood-pressure and lowered carbohydrate tolerance. In this class of neurotics, as an accessory to rest at

a quiet resort and a suitable dietary, a potassic, sodic, muriated and sulphated, alkaline-saline water, taken cold, will aid in correcting muscular tone, relieve the constipation, aid metabolism and stimulate gastric function.

## DISEASES OF THE GENITALIA—FEMALE AND MALE.

**The Female Genitalia.**—Chronic affections of the female organs of generation—disorders of menstruation, amenorrhea, dysmenorrhagia and affections dependent upon the climacteric, catarrhal disorders of the uterus and vagina (uterine and vaginal leucorrhea) following inflammatory disease of the pelvic organs, metritis, pelvic cellulitis, inflammatory exudations, absorptions, etc., are amenable to mineral-water treatment after the acute inflammatory stage has passed.

**Amenorrhea.**—Amenorrhea, or scanty menstruation, dependent on anemia or chlorosis, calls for a course of iron waters. The saline, ferruginous, acidulous waters and the sodic, muriated waters containing iron are the waters of election. If associated with digestive disturbances and constipation, or passive uterine congestion, the sodic, muriated waters will prove beneficial, or the gaseous, thermal, saline waters may be more useful.

If amenorrhea is accompanied with obesity the ferruginous, sodic, sulphated waters may give the best results. If intestinal stasis is a complicating feature the moor baths and the internal administration of a laxative, sodic, magnesic, sulphated water are indicated. This treatment is advantageous also in such cases nearing the climacteric, often accompanied with rheumatic and gouty symptoms and a tendency to obesity. If the latter symptoms are present pleuroglandular therapy, containing thyroid and ovarian extract, will be a helpful adjuvant.

**Dysmenorrhea.**—In dysmenorrhea dependent upon neuralgic and ovarian irritation a protracted course of hot baths for their sedative action is advised, and, when anemic, the sodic, ferruginous, sulphated waters are indicated. The congested types of dysmenorrhea, with hypertrophy of the uterus, do best on sodic, muriated, saline waters or alkaline, sodic and potassic, muriated waters. These cases do well from a prolonged stay, six to eight weeks, at a spa where balneotherapeutic treatment is administered and where a restful régime and suitable dietetic supervision is outlined amid pleasant and congenial surroundings.

**Menorrhagia.**—Menorrhagia caused from uterine atony or hypostatic hyperemia of the mucous membrane does well on a course of cold ferruginous sulphated baths, and a drinking cure on a potassic sodic sulphated water. But when this condition occurs near the menopause bathing in cold iron and brine baths is not advisable. Women suffering from diseases of the uterine organs should, as a rule, refrain from bathing during the menstrual period, except in cases of scanty

menstruation, in which it is advisable, by means of baths, to bring about increased flow of blood to the parts.

**Leucorrhea.**—Leucorrhea is best treated with alkaline, sodic, muriated waters as a "drinking cure." If anemia be present one of these waters containing iron is preferable. Douching with hot aluminic, ferruginous, sulphated acid waters is a helpful adjuvant.

In *uterine leucorrhea* mineral-water treatment does not offer much help, but abdominal congestion, due to ovarian irritation, may be helped by the administration of sodic, muriated, saline waters or alkaline, sodic, sulphated waters conjoined with hot baths.

**Chronic Metritis.**—Chronic metritis in debilitated women, accompanied with catarrhal symptoms, referable to the various mucous surfaces, do well on the sodic and potassic, muriated, alkaline waters, combined with long periods of rest at a quiet, restful resort. Other chronic inflammatory affections of the uterine adnexa, such as endometritis, perimetritis, parametritis, pelvic cellulitis, etc., may be treated in a similar manner. "Drinking cures" of the laxative, sodic, sulphated waters are often useful to relieve hyperemia of the parts and to favor absorption of exudates, through lowering of the blood-pressure in the neighboring areas. Where a soothing effect is desired mildly aperient, sodic and magnesic, muriated and bicarbonated alkaline waters may be substituted. In the anemic types one of the iron bicarbonated waters is excellent. In all chronic inflammatory disorders of the uterine organs warm full baths, sitz baths and the hot uterine douches above mentioned, at a temperature of 40° C. (105° F.), are useful adjuvants.

**Abortion.**—Abortion and a tendency to miscarriage are best treated according to the predisposing etiology. If accompanied by anemia one of the iron waters will be indicated with long periods of rest, preferably at a quiet, restful resort amid pleasing surroundings. In suspected specific disease the usual specific treatment should be ordered, and the sulphur baths used as recommended in the treatment of constitutional syphilis.

*Impotency* is oft-times amenable to balneotherapeutic procedures. The nerve invigorating iron, peat and sea baths are of first importance and applicable as an adjuvant for the relief of the etiological factors. A drinking cure on one of the sulphated bicarbonated alkaline waters, carrying potassium sulphate and calcium phosphate, as the Buffalo Mineral Water Spring No. 1, is advised.

**The Male Genitalia.—Spermatorrhea.**—Spermatorrhea resulting from anemia and general enfeeblement of the nervous system will be benefited by a drinking cure of the iron waters. The saline, ferruginous, acid waters may also be used advantageously, supplemented by ferruginous water baths and ferruginous peat baths. If hyperemia and congestion are contributing factors, due to abdominal stasis, hemorrhoids or constipation, the cold sodic, sulphated and sodic, muriated waters are indicated for the "drink cure." All such waters should be

freed as thoroughly as possible from carbon-dioxide gas, and ingested in small quantities in order to lessen the possibility of the gas irritating the renal and vesical apparatus.

**Epididymitis.**—Epididymitis and chronic inflammatory affections of the testicle and accompanying vessels are best treated, first, with reference to the etiology by the usual orthodox Galenical methods. The internal use of one of the iodine waters, the employment of iodine baths and thermal brine baths also prove efficient.

**Enlarged Prostate.**—Enlarged prostate is not materially benefited from balneotherapeutic measures, certainly not in the senile type, but when such enlargement is due to syphilis or the scrofulous cachexia, suitable medication with the administration of the iodine and bromine waters are of some use and sulphur baths will be helpful.

## THE USE OF MINERAL WATER IN FEVERS AND INFECTIONS.

**The Heat-regulating Center in the Brain.**—The clinical application of the knowledge of the mechanism of heat regulation in the body concerns the cause of fever. In most instances fever is produced by infections. In all discussions on the regulation of body temperature and the causes of fever we assume that a heat-regulating or thermogenic center exists in the brain. In fact, physiological research has established the fact that such a center is located about the optic thalami or corpora striata (see page 159).

**The Causes of Decrease and Increase in Temperature.**—The production of heat is increased by muscular action and diminished by inactivity. Loss of heat is increased by dilatation of the cutaneous vessels and increased flow of blood through them. It is diminished by contraction of the vessels in the cutaneous surface and dilatation of those in the splanchnic area, all of which is controlled through the thermogenic or heat-regulating center. If the skin surface becomes hot, the blood-vessels dilate and more blood circulates through them, the sweat glands are stimulated and heat and moisture escape into the surrounding air.

**Hyperpyrexia Caused by Toxins and Pathogenic Organisms.**—In all fevers there has been an invasion of pathogenic organisms whose metabolism gives rise to heat production and whose toxins thrown into the blood stream poisons the circulating fluid, thereby producing disorganization of the heat-controlling center and causing diminution in the loss of heat. In all infections accompanied by a rise in temperature, infectious microörganisms have invaded some part of the body. People in robust health are, by virtue of the cellular powers, immune to most infectious diseases; some possess an innate immunity to special diseases, as the negro to yellow fever. An acquired immunity is conferred upon the system by having recently recovered from the disease.

**Profound Disturbance of Bodily Function Caused by Fevers.**—Fever is accompanied by profound disturbance of nearly every function in the whole human system. The skin is hot and dry, or moist and warm, the alimentary system is upset, the mouth and lips dry and parched, tongue furred or dry and brown coated, with tip and edges red. The mouth is dry from suspension of salivation; intolerable thirst is present, due to dryness of the mouth; mucus and saliva are absent, thereby impairing relish, appetite and digestion. The urine is acid and concentrated and, owing to a deficiency of secretions, the bowels are confined. Due to the poisonous toxins in the circulation there is hyperpyrexia, increased respiration, quickened pulse with headache and disinclination to think or make mental effort—intellectual hebetude, drowsiness and wandering delirium. This picture is always present in typhoid, typhus and malarial fevers, in all the acute exanthematous fevers, influenza, pneumonia, septicemia, pyemia and, in fact, in all fevers and infections.

In all these fevers the prompt administration of an alkaline, sodic, calcic, magnesic, bicarbonated water is indicated. Its action will neutralize the urine, relieve thirst, remove the dryness of the mouth, aid in bringing about normal appetite, aid the digestive function, liquefy mucus and bowel contents and aid in their elimination from the system. It would almost be a crime to withhold water from patients of this type. A fever patient should be allowed from 4 or more liters of such water daily while the hyperpyrexia lasts.

The following spring waters, showing the amount of alkaline carbonates in milligrams per liter of water, are admirably adapted for the treatment of fevers.

| | Alkaline carbonates milligrams per liter. |
|---|---|
| Allouez Mineral Springs, Wis. | 639.43 |
| Bladen Spring, Ala. | 219.80 |
| Buffalo Mineral Spring, No. 1, Va. | 2681.90 |
| Buffalo Mineral Spring, No. 2, Va. | 3243.15 |
| Capon Spring, West Va. | 672.75 |
| Chippewa Spring, Wis. | 84.00 |
| Clifton Springs, N. Y. | 1482.00 |
| Gailbreth Springs, Tenn. | 280.15 |
| Hot Springs (Boiler Spring), Va. | 1696.50 |
| Manitou Springs, Col. | 8362.00 |
| Paradise Spring, Maine | 31.15 |
| Poland Spring, Maine | 121.40 |
| Roscommon Spring, Penn. | 31.85 |
| Thompson's Bromine-Arsenic Spring, N. C. | 219.80 |
| Warm Spring, Ga. | 403.00 |
| White Sulphur Spring (Sharron), N. Y. | 1564.00 |
| White Rock Spring, Wis. | 2088.45 |

## CHAPTER XI.

## SUGGESTIONS FOR THE SELECTION AND USE OF MINERAL WATERS.

**Pathology of Ailment, a Guide in Recommending Mineral-water Treatment.**—The first thought in designating a mineral water suitable for a patient must take into consideration not only his individuality, his habits of thought and living, his temperament and his idiosyncrasies, but also the pathology of his ailment, determined after a careful clinical examination and laboratory reports and the character of the predominating chemical constituents of the water as revealed by chemical analysis. The mental attitude of the patient on parting with home and friends must be considered. Some patients are prone to develop nostalgia on being separated from the family hearthstone, to whom a prolonged stay at a strange place becomes very depressing, and any gain that might be derived from a sojourn at a spring or spa may be offset by worrying about friends and the family left at home. Under such circumstances an agreeable companion should always accompany such a patient to the resort.

**The Diathesis Behind the Disease to be Reckoned With.**—The second thought must include a clear and comprehensive insight into the overruling factors of the patient's ailments or complaints, whether the disease is predominated by some particular diathesis, viz: rheumatic, gouty, scrofulous or certain disorders of metabolism; of the gastro-intestinal tract, the genito-urinary tract, of the circulatory system; with reference to the water, whether its constituents, both principal and auxiliary, meet the requirements both of the disease and the diathesis and the disorders of metabolism. If the patient presents symptoms of catarrh of the bladder in a rheumatic subject a calcic, carbonated alkaline water is indicated; in a patient suffering from digestive disturbance with gouty symptoms a sodic, calcic, muriated, alkaline water would be appropriate. In an eczematous subject with rheumatic history calcic waters containing sulphuretted hydrogen will be found useful. In anemia or any depraved state of the blood and blood-making organs, where the coloring water is below normal, an alkaline water containing the bicarbonate of iron will be found useful. This is the practical method of prescribing mineral waters, and it is always feasible to consider the problem from this angle.

**Climatological and Meteorological Conditions in Selecting a Spa.**—*The Spring.*—Furthermore, in addition to the medicinal properties of the

water, we must take into consideration the location of the spring, its elevation above sea level, the climatic conditions, temperature and general meteorological conditions of the location of the resort. It is well known that some patients improve more rapidly at a resort with a high elevation above sea level, while others find the greatest improvement and comfort at places not much above sea level. Again, certain diseases do well in a comparatively dry atmosphere and would be most seriously affected by a moist atmosphere. Moreover, a cool climate is advantageous to one class of patients, while others do best in a warm climate.

The *surroundings and environment of a spring or spa* are always important factors to be considered when selecting a place of residence of a patient. Nothing could be more unfortunate for certain types of patients than a sojourn at one of the crowded ultrafashionable resorts, where the social activities and continual excitement permeate the place; on the other hand, there are types of despondent individuals who would be greatly benefited by the gay conviviality of such a place.

**Class of Waters, Dosage and Frequency of Taking Waters.**—When the class of waters and the resort have been decided upon for a particular patient, the dosage and frequency of taking the water are to be considered. Where the composition of the water, its chemical constituents and gases are known a mental calculation can be quickly made as to how much of each ingredient the patient is receiving daily, according to the number of glasses of water drunk. Experience has taught us that alterative medicines act best when administered on an empty stomach, therefore the morning hours, before breakfast, and in the afternoon, before dinner, are the proper times for taking waters of this class. An individual seeking the restoration of health should be advised to cultivate the healthful virtue of early rising and none the less exemplary habit of early retiring, and to drink the waters as advised by the medical director of the resort, and to strictly follow his advice as to diet and exercise. It is too much to expect that the most potent mineral water will overcome the voracious indiscretions of a good trencherman, the tipping dissipations with the wine cups of Bacchus and the tripping of the terpsichorean toe until the wee small hours of the morning. Excesses are dangerous, and if one disobeys the laws of Nature he pays the price; dissipations in eating, drinking, exercise and want of proper rest do not contribute to health and longevity. Such indiscretions are often the beginning of many unpleasant ailments which might easily have been prevented. Sleep, diet and exercise ought to be comformable to the respective habits and temperaments of the individual, and for the guidance of those who seek the restoration of health through a sojourn at a spring or spa one ought neither to be taxed with privations nor permitted to indulge in Bacchanalian, terpsichorean or gourmandizing debauchery. The period of sleep should not exceed eight hours, and not infrequently six will be sufficient. Exercise is of prime importance, walking, horse-

back riding, golf, tennis and motoring, which ever the resort physician advises.

The *dosage of mineral waters* varies so much with the different springs that no hard and fast rule can be laid down (see Chapter VIII). In a general way, however, from 2 to 4 liters of water daily, depending on the concentration, will be about the average amount—2 glasses before breakfast, 3 between breakfast and lunch and 3 between lunch and dinner, and 2 more before retiring in good routine. It is good practice to advise patients to allow fifteen minutes between each glass of water and at least one hour before the next succeeding meal is taken. While undergoing a course of mineral-water treatment the dietary should be carefully supervised in accordance with the pathology of the patient's ailment and excesses rigidly guarded against. The combination of mineral-water treatment with suitable dietary, amid cheerful surroundings, change of climate, delightful scenery, interesting amusements and suitable exercise, frequently whets up the appetite, to which the invalid may long have been a stranger, especially if the patient belongs to the dyspeptic, neurasthenic class. While the return of the appetite is a happy indication of the favorable reaction of the water, permanent relief may be hindered by gratifying the inclination to too much indulgence at the dinner table.

The *length of time necessary to complete a "water cure"* cannot be predetermined—a month at the minimum and perhaps two or three, depending on the ailment of the invalid. When a patient has been sent to a spa best suited to his or her ailment, according to the best information available, he should remain there until he has given the waters a fair trial, and not vacillate from spring to spring. There are valetudinarians who make the round of springs and resorts, drinking here a few days and there a few days, like Ponce de Leon searching for the fountain of youth. They might as well enter a drug store and *seriatim* dose themselves with a potion from each bottle in the druggist's shop. This, of course, would be foolish in the extreme, but not more so than the impropriety of rapidly changing from one spring to another, without tarrying long enough at one to receive the beneficial effects of the waters. Such rounders literally waste their time and money, and thus debar themselves from any permanent good by devoting their time among the springs rather than at any one of them. This ill-advised practice on the part of some invalids is of serious moment to themselves, but persons who visit the springs for pleasure or amusement, or to secure relaxation from business perplexities, and require only the tonic of travel, change of climate and environment may, with propriety, go the round of resorts with benefit.

**Medical Supervision.**—The personality of the medical director of a spa or resort plays an important role in the progress of the patient, and his scientific attainments are considered by the family physician in determining where to send the invalid. One reason for the great popularity of the European spas and their fame for the scientific

treatment for certain affections of the human body is not altogether due to the medicinal properties of the waters, but largely to the personality of the medical supervisor and to his scientific attainments. A health resort or spa may be well managed in all other respects, yet if it has at its head a medical man not properly qualified to give the needed medical direction and whose personality does not fit him for the position, the institution is apt to be tabooed by the family physician when selecting a health resort for his patient. The physician should never prescribe a mineral water until he has had an opportunity to carefully study the analysis, which should reveal to him the therapeutic properties of the water under consideration. His patient then should follow his directions just as he would if taking a prescription compounded at the apothecaries. If a change of climate or scene are indicated to supplement the mineral water, the physician should select the spring or spa, after carefully considering the chemical nature of the water, the character of the scenery, environment, altitude and the prevailing meteorological conditions. It is the bounden duty of the family physician in such a case to write to the medical director of the spa or resident physician at a spring resort, giving a full history of the patient's illness, and offer any timely suggestions which he may deem fit. It is evident that a patient arriving at a resort without such a letter will have to be placed under observation and be examined for several days before he can be placed under appropriate treatment. A strict adherence to such a plan of procedure would put mineral hydriatics upon a satisfactory professional standard of usefulness, which we would gladly welcome.

**Dietetic Supervision.**—To secure the full benefit of a mineral-water cure the patient's dietary should be carefully supervised. This means more than the simple interdiction of tea or coffee. The dietary should be adapted to the pathology of the invalid's ailment after a thorough examination and a knowledge of the functionings of the gastro-intestinal tract. Without a proper examination of the stomach contents after a test-meal, repeated if necessary, no specific diagnosis can be made in cases of chronic gastric disturbance, nor in cases of kidney disease until after repeated urinary examinations have been made. After the laboratory reports have been examined the medical director can intelligently canvass the situation and direct the dietary along scientific lines, as well as prescribe the mineral water suitable to the patient's ailment. The regulation of the dietary and the use of the mineral water are complementary; the former may be negatived by the latter, and *vice versa*. Perhaps in no instance does diet play such an important role as in the cases where the use of a mineral water is properly indicated.

**Exercise and Rest.**—Exercise and rest are important factors to be considered, both at home and at a health resort. Patients left to their own initiative are apt to overdo the matter on the one hand by overtaxing their physical condition, trying to keep the pace set by

one of their more physically fit companions on the hike or on the golf course, or, on the other hand, make no effort at any form of exercise. Often a proper mode of life outlined by the medical director at a health resort, together with a suitable dietary and a mineral water prescribed with a knowledge of the pathology underlying the patient's infirmities will greatly aid in getting rid of the distressing symptoms, bringing about a cure or preventing a return of the disease. Rest and the conservation of the patient's energy are always important factors for the restoration of health through normal functioning of previously diseased organs. Nature repairs damages slowly. A diseased process must be checked before repair can take place. An irritable kidney with a trace of albumin and a few casts is the danger signal of kidney degeneration These organs need rest, a dietary which puts little work on the kidneys, and a calcic, bicarbonated, alkaline water, with the restriction of the patient's daily activity, and the perseverance in the constant and liberal use of the mineral water for a few weeks will greatly aid in the rapid restoration of these organs to normal function.

Invalids too often expect immediate relief from distressing symptoms; others again simply desire relief with little or no anxiety concerning the pathological conditions going on within their bodies; still others, aware of some slight physical disturbance, are continuously taking some form of treatment for more or less imagined ailments. These types of patients all need the careful supervision of a competent physician to direct their daily life, from arising to retiring, with strict supervision of their dietary, periods of rest, exercise, bathing and the drinking of the waters, taking care that the type of mineralization is suited to the pathology underlying the diseased condition.

Patients should be advised just what to expect from the system of baths and taking the "water cure," and should have pointed out to them that in certain types of maladies all that can be hoped for is slight improvement of the more aggravated symptoms. A remedy for a disease does not necessarily mean a cure, but relief from distressing symptoms is always welcomed. Therefore, a spring or spa should be cautious in withholding extravagant promises.

**Confidence in Medical Hydrology.**—Many consecutive years of experience in prescribing mineral waters in various diseased conditions have increased my confidence in their therapeutic properties, so much so that I yield to no one in admiration of their pleasing adaptation for many of the ills to which the human flesh is heir. As independent remedies, totally apart from Galenical adjuvants, they are often fully sufficient to obtain the desired results. Each type and class throughout the whole catalogue of mineral waters have their own special sphere of usefulness, which must be borne in mind by the discriminating physician in the treatment of particular types of cases. Therefore they should be analyzed, classified and labeled, so to speak, just as we have tried to do in this volume. The reader will observe that both a medicinal classification and a chemical classification follows the analysis of each spring throughout the work.

# PART III.

# BALNEOTHERAPY.

## CHAPTER XII.

## RATIONALE OF HYDROTHERAPY.

By GUY HINSDALE, A.M., M.D.

**Balneotherapy.**—Hydrotherapy is a term used to designate that part of the science of medical hydrology which deals with the use of plain water as distinct from the use of mineral springs. To the latter the term balneology has been applied. Its use dates from about the middle of the nineteenth century, while the word hydrotherapy is somewhat older and is in common use in France, Italy and Spain. In the United States the commoner word is hydrotherapy and there is not a great deal of discrimination used in applying it, so that it has heretofore been used to include the spa treatment, which is strictly a form of balneology.

In hydrotherapy there is an advantage over balneology, in that the water required is found almost anywhere, provided there is some means of heating and cooling the water besides apparatus such as tubs, douches, sprays and the means to regulate their temperature, pressure and duration.

The *simplest methods* have sometimes had the greatest following: Vincent Priessnitz took his water supply from a mountain stream, and made it discharge from a pipe 6 feet above the patient's head; Father Kneipp's favorite method was to use the water, cold, from hose, and douche the limbs of the thousands who came to him. It is probably true that the modern apparatus designed and constructed in England and America is far ahead of the equipment found elsewhere.

*Hydrotherapy* and *balneotherapy* go hand in hand, and what can be said of one may also be said of the other; the dangers are the same and the advantages are very similar. If it were not for the fact that plain water is applicable to all forms of hydrotherapy, thousands who live in our cities and towns would be deprived of its advantages, for few comparatively are able to visit the natural mineral springs, numerous as they are.

Water derives its varied powers from its remarkable flexibility of administration; that is to say, it may be applied as a solid, a liquid or a vapor. It may be used in the natural state or hot or cold. It may be applied in pools, tubs, jets or sprays, and with or without pressure; in the quiet of the sickroom or in the open river or ocean. It has a capacity for infinite gradation, both as to its physical and its chemical characteristics.

**The Necessity for Systematic Instruction in Hydrotherapy.**—Very little, if any, instruction is afforded medical students in this branch of therapeutics. The late Dr. Baruch held the first chair in a medical college, Columbia University, devoted to hydrotherapy, and no one has succeeded him. Some practical instruction in hydrotherapy is given to students of the Medical School of the University of Pennsylvania. Just as in the case of other physical measures, hydrotherapy, to be successful, requires experience on the part of the physician and the attendant or nurse, together with a nice sense of adaption to the needs of the patient. On his part, it requires confidence, punctuality and obedience and a spirit to persevere throughout the course prescribed. Hence, it is that city life is not conducive to the best results; at least when compared with the advantages to be derived at some health resort, where arrangements are usually made for the strict observance of the cure. Here, there is the encouragement of the example of others, the attractive surroundings, free from the old associations, and the aid of attendants who have made a specialty of that kind of treatment.

**The Value of the Prescription in Hydrotherapeutic Practice.**—It is a great advantage to order hydrotherapy according to a specified method, viz: in the form of a prescription. This aids the attendant in following orders and aids the physician in keeping his records. Prescriptions should be referred to when changes are made as to the temperature or duration of the bath or other procedure employed. Precise directions by the physician and correct observation and reports by the attendant are essential.

Of course, the unusual attention paid to the skin is the secret of the cure. Hitherto every other organ has probably been treated—the heart, by tonics; the liver, by stimulants; the nervous system, by sedatives—which have left the skin in bad order.

**Surface Area of the Skin, Importance of Considering.**—In these neglected cases baths and packs help restore the skin to its proper function; excretion is resumed and the other organs are proportionately relieved of their burdens. The skin has a great capacity for blood, and its 15 square feet in the average adult are bountifully supplied with nerves and innumerable secretory and excretory glands. Through its nerves we are kept in touch with the external world; we thus recognize the slightest changes of touch, pressure, pain and temperature; but this unending stream of sensory impulses does not necessarily impress the conscious brain. The response to these efferent impulses

is largely automatic, even during the waking hours, whether we are at rest or in the highest activity.

**The Heat-regulating Mechanism.**—There is a heat-regulating mechanism by which the blood is maintained at a nearly constant temperature of 37° C. (98.4° F.). The heat produced within the body is balanced by the loss through the skin and lungs to the outer world. Unlike the lower primates and other furry, hairy or feathered animals, man has to protect himself more or less with clothes and, notwithstanding the vast extremes of temperature encountered throughout the globe, the blood keeps pretty close to the normal figure. In this power man excels all other animals. (See page 149.)

The skin is the buffer, so to speak, between the internal organs and the outer world, and we must note that skin temperatures are not the same as internal temperatures, and may fall 10° or 15° lower. Hence, it is that the "indifferent or neutral bath employed sometimes under the name of continuous or flowing bath is usually fixed at 33.3° C. (92° F.). In that bath the patient may rest day and night without noticing any departure from the proper degree of comfort. I have elsewhere discussed the function of the skin as regards mineral constituents, dissolved in the water used for baths.[1] While it is not germane to pure hydrotherapy, it may be said that the uninjured skin does not absorb mineral constituents of a bath, but that gases accompanying these baths may absorb mineral constituents; but that is not true of the skin.

The whole trend of skin activity is from within outward. Perspiration and the glandular secretions pass out; nothing is taken up from the water. Saline waters used in bathing do not render the blood more salt. This tidal effect from within outward is easily recognized in loss of weight during the hot bath, followed by a hot, dry, blanket pack. The loss during an hour devoted to this procedure will measure 1, 2 or 3 pounds, as I observe almost daily in hydrotherapeutic practice.

If one gains during a course of bathing it is due to a better hygiene, a promotion of healthy bodily functions, notably digestion and assimilation. It is one of the advantages of hydrotherapy properly administered to varying needs that a patient can usually be turned in the proper direction as metabolism and anabolism may require.

**Influence of Hydrotherapy on Metabolism.**—During recent years great attention has been directed to a study of metabolism in both normal and pathological conditions in the human subject. Hydrotherapy has a marked influence on metabolism, varying in degree as the temperature of the medium departs from the indifferent point. In using tubs with water at 33.3° to 34.4° C. (92° to 94° F.) there is no appreciable effect on heat production or heat loss, this temperature corresponding to that of the skin.

Fortescue Fox[2] believes that the indifferent point of water is often placed too high, and cites as an example the use of baths in cardiac and cardiovascular disease. Such baths, while supposed to be indiffer-

ent, may really exert an undesirable thermal effect. The actual point varies somewhat for different individuals, in health, as Fox says, and may be lowered many degrees in conditions of ill health. The determination of the indifferent point for an invalid undergoing bath treatment is sometimes a matter of great importance.

When the indifferent point is ascertained, not *a priori*, but by experiment, we may expect the metabolism to remain unchanged, and the so-called prolonged or continuous bath may be employed for weeks or months. Such baths are now adopted in the treatment of spinal fracture, obstinate skin disease or in disturbed mental states. These baths, therefore, tend to equalize peripheral stimulation and are sedative in effect.

In order to preserve a constant temperature, whether exposed to heat or cold, all warm-blooded animals have two inherent faculties: One a *physical regulation*, causing increased or diminished heat loss; the other, a change in metabolism, thereby varying the heat production and constituting the *chemical regulation*. This matter of heat regulation is quite independent of the protection afforded by clothing.[3]

Physical regulation is controlled by processes in the skin, where cold produces contraction and a relatively bloodless state. This contraction checks loss of heat by radiation, conduction and water evaporation. There ensues a secondary hyperemia, which follows the withdrawal of ice or cold, called the "reaction." Its appearance means increased heat loss and marks the end of the control by physical regulation. This is of prime importance in the practice of hydrotherapy. Great stress is always laid on a "reaction," and when baths vary very much from the indifferent temperature it is highly necessary to to secure it. Friction in the bath and the addition to the water of stimulating substances, such as chlorides or carbonic-acid gas favor its appearance. A healthy reaction is not always noted at the beginning of a course of baths, but it can be cultivated or brought out as the skin is trained to react.

**Body Reaction to Heat and Cold.**—This reaction of the body occurs as a consequence of both cold and heat, and it is the occurrence of this physiological feature which determines the effect of hydrotherapy. Both air and water may be used in this connection, but water is generally preferred because it has a greater specific heat and a greater coefficient of heat activity. Regarding the *chemical regulation* of the bodily warmth, whereby there is an increased production of heat in the presence of external cold, some physiologists are skeptical.[4] There is a growing belief that in the human subject the increase in metabolism at low environmental temperatures is due entirely to muscular activity that involves conscious or unconscious shivering. On entering cold water, the effort of swimming furnishes the required caloric energy.

In the case of hot-water baths, or other measures, the regulation of the body temperature by evaporation, radiation and conduction may

become insufficient, giving a stimulus to metabolism and an added temperature to the body cells. It has been shown that an effective atmospheric temperature of 40.5° C. (105° F.) the heat production is twice as great as at the normal temperature of 18.5° C. (65° F.). Whenever the body cells are overwarmed, whether by external temperature conditions, as afforded by baths in water or heated air, or through production of heat through toxic processes, metabolism is increased.

Man is peculiarly susceptible to hydrotherapeutic effects; he has no natural protection and the clothing he wears makes him sensitive to temperature changes. This forms a kind of habitual thermal zone about the body having a temperature fairly constant at about 32.2° C. (90° F.).

In this connection it is interesting to note the remarkable power of adaptation to its surroundings that the human skin possesses. This is seen in the practice of heliotherapy, a related form of treatment, in the course of which the skin, by gradual and repeated exposures to sunlight, acquires a deep pigment, or tan. When tan is well developed the skin resists the ordinary effects of cold and heat and, especially in the case of children, permits an outdoor life with little clothing, at least during the hours of sunshine, whether in the higher Alps or at the seaboard.

The rapidity and degree of reaction for cold vary in different individuals. They are delayed in the weak and feeble but develop early and rapidly in the robust, especially if they have been in the habit of taking cold baths. The reaction, as most of us know by personal experience, may set in while one remains in the bath or as one comes out of it. It is a common experience of sea bathing, and is a *sine qua non* if it may be indulged in with safety. Long-distance swimmers have this power developed to an unusual degree.

The cutaneous nerve-endings are sensitive to heat and cold and convey impulses to the vasomotor, respiratory and cardiac centers and to the muscles, causing them to check automatically the injurious effect on the external stimulus wherever it is. The heat-regulating function has a far-reaching effect and must be appreciated in hydrotherapeutic studies, for it is at the basis of the science.

The excretory function of the skin is, of course, of prime importance, but we should note that the belief that mechanical suppression of the many deleterious substances of effete nature will cause death is not altogether true. Impervious substances applied to the skin might be fatal by disturbance of the heat-regulating function.

Carbon dioxide is exhaled at a much more rapid rate by either cold or hot applications. Urea and uric acid, likewise, are probably also excreted in larger amount.

Hippocrates stated that the elevation of temperature that occurs in connection with most acute infectious diseases is, within limits, remedial in purpose and effect, and this is a principle we are slow to

recognize. It apparently follows that temperature-elevating baths may be beneficial by aiding resistance to infection, especially when followed by a short, cold bath or douche, and may directly or indirectly favor the production of antitoxins.

The rate of heat production is increased in the cold bath by means of vigorous rubbing as much as 44 per cent; this may, to a great extent, diminish the temperature reducing effect. Short, cold, shower baths are said to increase heat elimination from 25 to 65 per cent and even more if mechanical friction is applied. The more the temperature of the bath deviates from the body temperature the stronger is the effort of the body to overcome this loss or gain in heat. A single hot-air bath may have little effect comparatively, but by a series of hot-air baths or hot-water baths this effect is undoubtedly increased.

**The Metabolic Effects of Heat on the Blood, Urine and Sweat.**—Some recent American studies of the therapeutic application of heat upon the blood, urine and sweat have been recorded by Cajori, Crouter and Pemberton, of Philadelphia.[5] They have demonstrated that as a result of external heat, such as in electric bakes, the blood becomes more alkaline; there is a fall in its total content of carbon dioxide and a slight rise in alkali reserve. These changes in the acid-base equilibrium of the blood cause compensatory changes in the urine and sweat. The loss of carbon dioxide by the body during the heat experiments is of prime importance as a factor that leads to a greater alkalinity of the blood; an increased blood flow during a hot-air or electric-cabinet bath thus favors an increased gas exchange between the blood and other tissues. In these experiments the subjects, 15 in all, were exposed to the heat of an electric cabinet of a portable type, in which during the first twenty minutes the heat near the body was 48.9° to 54.4° C. (120° to 130° F.). The bakes were continued for another twenty minutes, making forty to fifty minutes in all.

The pulse-rate, temperature-rate and oral temperature were taken at ten-minute intervals. At these intervals blood was taken from the median vein. The carbon-dioxide content, oxygen content and capacity of the blood and the hydrogen-ion concentration were also noted. The details of this very careful study are fully given by the authors in their report.

The results show that the total $CO_2$ content of the blood was lower after exposure to heat than before heat was applied. At the same time the alkali reserve of the blood was somewhat greater. There was no indication of concentration of the blood, if one accepts the oxygen capacity of the blood as an index of the blood volume changes.

Cold applications, or minus applications as they are sometimes called, are not less valuable in their place than are the applications of heat or plus applications, but they are not always so readily undertaken by the physician or the patient. There is always the fear of shock from the sudden access of cold. This arises from the fact that most of us are familiar only with the depressing effect of cold. Igno-

rant and savage races have for centuries in North America, Russia and Finland used a steam bath, made by throwing water on stones heated very hot inside rude tents, and then jump in the snow for a few minutes to produce the reaction. It is all based on a good physiological principle—the higher the heat of the preliminary measure, the greater contrast from cold is permissible.

**Rules to Obviate Shock.**—The shock should be brief; it need not be more than an unpleasant surprise to the nervous system, as Baruch says; a brief shock is stimulating, but when prolonged the surprise ceases, and it may become a real shock, detrimental if the patient is unconscious or the bath is persisted in despite the patient's protestations. Like other physical measures, such as light or electricity, it must be used with intelligence and proper control. It is then devoid of danger. Baruch[6] has formulated some simple rules which may tend to obviate shock:

1. Draw the edge of the nail of the index finger, with very gentle pressure over the skin of the chest; a pink line appears if the patient's resisting capacity to shock is good. The more rapidly the line appears and the more vivid the color, the better will the patient bear cold procedures. Response to this mechanical excitation furnishes a fair index of the ability to respond to thermic excitation.

2. Always use friction during the procedure when cold water is applied. There is one exception—the wet pack. In the use of the wet pack we have no advantage from any mechanical aid and the reaction depends entirely on the vital powers of the patient.

3. Reduce the water temperature 1° or more as indicated *at each treatment.* A sudden, brief application of cold water is not dangerous; it is rather a stimulant; it is useful to restore a fainting person.

4. When the patient apparently does not respond well to cold water he can be accustomed to it in many cases by using water of the same temperature over a smaller surface and for a shorter period. The area treated can then be increased and the time lengthened. It is best not to discontinue or postpone the treatment or raise the temperature if originally fixed with judgment.

Although the patient may complain of chilliness during the treatment, the latter must not be abandoned, since the cause may be emotional. If the patient feels chilly twenty or thirty minutes after the procedures, reaction may be regarded as defective; the next treatment, however, must be made *with the same water temperature,* but more brief and gradually increased until he reacts to the same temperature. If the patient does not feel uncomfortable one-half hour after the procedure, reaction may be regarded as *fair;* if the patient feels exhilarated reaction is *good,* and if, in addition, the skin becomes pink during or after the treatment reaction is *excellent*

**Effect on the Kidneys.**—Increased diuresis occurs from cold baths, but it is not clear just how this occurs. It certainly is not due to the absorption of any water through the skin, and the diuresis is probably

not dependent on a temperature effect. It has been suggested that the circulatory and respiratory changes observed on immersion in hot and warm baths appear to depend mainly on changes in body and skin temperature, but that no such dependence can be demonstrated for the diuresis.[7]

J. Q. Griffith and H. R. Hansell,[8] of the University of Pennsylvania, have made studies of the effect of abdominal pressure on urine volume. They conclude that abdominal pressure without the accompaniment of the bath can produce a diuresis. The effect pressures were comparable to the hydrostatic pressure on the abdomen in the baths. As the venous pressure in the abdomen is raised as the result of the external pressure, so the diuresis is the result of the pressure in the bath.

The *beneficial effect of cold baths in the infectious fevers is*, of course, explained by an increased elimination of poisons and a reëstablishment of the circulatory equilibrium. It is supposed also that cold baths influence various protective processes in the body, but the evidence on this point is meagre. Hare, in discussing this matter, says that one of the reasons for supposing that cold baths increase the protective processes, is that the benefit that accrues is so great that it is inconceivable that the mere equalization of the circulation, the reduction of temperature and the elimination of poisons can be solely responsible. As a matter of fact, we know far too little, except empirically, of the influence of cold baths upon the body, and for this reason further studies are needed.

**Influence of the Cold Bath on Glycogen of Body.**—Dr. Graham Lusk[9] reported the results of his investigation of the influence of cold bathing on the glycogen content of the body of man. He found that when normal men are immersed in water which is exceedingly cold severe shivering at once comes on, and that there is a rapid utilization of body glycogen, as indicated by a fall in respiratory quotient to the fasting level. He also found that the cold bath very greatly increased heat production, which is a point of considerable interest in that, in the past, many physicians have supposed that the cold bath was advantageous in that it exercised an antipyretic effect, but for many years those who have regarded moderate fever as a protective process designed by the body to combat the infection have also recognized that the production of heat as the result of the cold bath was considerably increased, and that although the peripheral portions of the body may be cooled by this means there is no actual decrease, but rather an increase, in the total body temperature.

The chief criticism which can be urged against Lusk's experiments is that the water which he employed was excessively cold, namely, as low as 10° C. (50° F.), but in all 3 of his subjects, while the danger of such cold bathing was considered, no ill-effects were induced, save that after the bath there was considerable muscular lassitude. It is evident, too, that in all of his patients the circulatory condition was

good, since the skin became intensely red and they promptly reacted to the bath. He found too that the blood-pressure rose considerably, but that it was difficult to estimate it because the severe shivering interfered with accurate test with the sphygmomanometer.

The good results of cold-water sponging, affusions or baths are probably attributable more to a reflex action on the nerve centers than to the incidental withdrawal of heat. Hence we should not fix our attention on heat reduction, especially from the higher stages of 42.2° or 42.7° C. (108° or 109° F.) to near the normal mark in a single bath, but rather on the moderate use of cold, a better action of the heart and respiration and on the state of the nervous system.

## SWEATING.

**Toxic Poisons Excreted Through Perspiration.**—It is commonly believed that the sweating process which precedes, accompanies or succeeds the bath, while relieving the kidneys of some of their functions, carries off in the sweat certain toxic substances, thereby causing the skin to eliminate what the diseased kidney is unable fully to accomplish. In other words, the skin acts vicariously for the kidneys as an excretory organ. But this view is not accepted by some of those most competent to judge, and such men as Senator and von Noorden, in Europe, opposed this theory. Senator says: "Warm baths are useful in removing excess of water, but the specific urinary constituents, which are the mischief makers, are not removed in any appreciable quantity even by the most profuse sweating." Von Noorden holds that the only benefit of sweating lies in the withdrawal of water from the blood and tissues. He and his pupils have demonstrated that the perspiration of nephritics contains only a trace of urea—the maximum is about 1 to 1.3 gm. in the total quantity of profuse sweat, while the remaining constituents are but harmless substances. He further states that poisonous substances in the sweat have never been found.

The increase of sweat is accompanied by a very small elimination through the skin of traces of urea, fatty acids and aromatic substances as well as gases, particularly carbon monoxide. We believe that toxic substances leave the body in this manner and the sweat may be assigned a depurative action; however, the chief agency is undoubtedly the liver and bowels.

The loss of water from the body due to sweating may amount to 3, 4 or even 5 or 6 pounds in hard contests, such as boxing, rowing, and tennis. If this loss through the skin be considerable, the volume of urine drops and it becomes more concentrated.

Of course, one is prompted by thirst to drink water, and if plenty is taken the urinary balance is restored as to both quantity and quality.

As an aid in the selection of temperatures for various physiological effects, the following table prepared by Kellogg will be found useful.[10]

COMPARATIVE SUMMARY OF THE CHIEF EFFECTS OF COLD AND HEAT.

| COLD | HEAT. |
|---|---|
| *General.* | *General.* |
| Primary, depressant. | Primary, excitant. |
| Short, excitant by tonic reaction. | Short, depressant by tonic reaction. |
| Prolonged, depressant. | Prolonged, mixed, excitant and depressant. |
| *Special.* | *Special.* |
| *Skin:* Action, diminished activity. | *Skin:* Action, increased activity. |
| Reaction, increased activity. | Reaction, diminished activity. |
| Diminished sensibility. | Diminished sensibility. |
| *Cold.* | *Heat.* |
| *Heart:* First quickened, then slowed. | *Heart:* First slowed, then quickened. |
| Increased force. | Decreased force. |
| *Vessels:* Action, contraction. | *Vessels:* Action, contraction, then dilatation. |
| Reaction, dilatation. | Reaction, contraction. |
| Increased tone and activity. | Lowered tone paralysis. |
| Local anemia, collateral hyperemia, with reaction, local hyperemia, collateral anemia. | Local hyperemia, collateral anemia, with reaction, local anemia, collateral hyperemia. |
| Short, reflex dilatation of visceral vessels. | Short, reflex fluxion and derivative effects. |
| *Nerves:* Benumbs and paralyses. | *Nerves:* Excites. |
| Excites by tonic reaction. | Depresses by atonic reaction. |
| *Muscles:* Short, increased excitability and capacity. | *Muscles:* Short, lessening fatigue effects. |
| Prolonged, lessened excitability and capacity. | Prolonged, diminished capacity and excitability. |
| *Lungs:* Slows and deepens respiration. | *Lungs:* Quickens and facilitates respiration. |
| Increased amount of respired air. | Diminished amount of respired air. |
| Increased $CO_2$. | Decreased $CO_2$. |
| Increased respiratory quotient. | Diminished respiratory quotient. |
| *Stomach:* Increased HCl and motor activity. | *Stomach:* Decreased HCl and motor activity. |
| *Kidneys:* Congests and excites. | *Kidneys:* Renders anemic and lessens activity. |
| *Animal heat:* Short, increased heat production. | *Animal heat:* Short, diminished heat production. |
| Prolonged, diminished heat production. | Prolonged, increased heat production. |
| *Blood:* Increased blood count, especially leukocytes. | *Blood:* Decrease in number of red cells, increase in number of leukocytes. |
| *Metabolism:* Increased $CO_2$. | *Metabolism:* Decreased $CO_2$. |
| Increased urea and improved oxidation. | Increased urea and general proteid waste. |
| *Tonic Reaction.* | *Atonic Reaction.* |
| 1. Vasodilatation. | 1. Vasoconstriction. |
| 2. Skin red. | 2. Skin pale. |
| 3. Pulse slowed. | 3. Pulse-rate increased. |
| 4. Artêrial tension increased. | 4. Arterial tension diminished. |
| 5. Skin action increased. | 5. Skin action decreased. |
| 6. Temperature lowered. | 6. Temperature lowered. |
| 7. Feeling of invigoration. | 7. Languor. |
| 8. Muscular capacity increased. | 8. Muscular capacity decreased. |
| 9. Amount of respired air increased. | 9. Amount of respired air decreased. |
| 10. Heat production increased. | 10. Heat production decreased. |

**Induced Phenomena During a Course of Hydrotherapy.**—These have been noted for ages, but nevertheless come as a surprise to the patient.

A word of warning that he may have some latent focus of infection may do a good deal to disarm criticism in case the unpleasant reaction should occur. Toothache from a carious tooth may set in; there may be a latent focus in a joint or even in ovarian tubes that will take on unexpected activity. If hyperemia attending hydrotherapy promotes absorption of morbid products, one should expect to get a moderate reaction. Too little is useless and too much is harmful and discourages the patient. It requires some skill to adjust the remedy to the individual requirements.

An interval of a day or two of rest between measures usually restores conditions to normal. In nervous persons with a tendency to arteriosclerosis there may be nervous crises, vertigo or buzzing in the ears; but these are usually transient. Paralysis is usually deemed a counterindication to hydrotherapy.


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## CHAPTER XIII.

## THE TECHNIC OF HYDROTHERAPY.

By GUY HINSDALE, A.M., M.D.

In the *practice of hydrotherapy* the author strongly advocates adherence to a definite technic, and a precise technic of hydrotherapy has been his aim for over twenty years of practice in this field. He may, therefore, be pardoned if he repeats what he has previously published from time to time with the object of bringing these different procedures into some systematic order and expressed, as far as possible, in terms that will tend to the standardization of hydrotherapy.

As a member of the International Society of Medical Hydrology he realizes that practitioners in America generally lack definite knowledge of these methods, and rarely, if ever, personally apply them. Satisfactory results cannot be obtained with indefinite prescriptions which fail to specify temperatures, pressures or duration of the measure prescribed To leave details to the attendant without real knowledge of what is going to be done to the patient is all wrong. Slipshod methods have no place here any more than in any other form of physiotherapy.

**The Technic of Hydrotherapy.**—The technic as formulated herein has been examined and approved by the late Dr. Simon Baruch[1] and Dr. Curran Pope,[2] and more recently by Dr. George K. Abbott.[3] No one man, naturally, can cover the whole field of medical hydrology. Many do not treat insane patients; others have had no experience with apparatus such as the whirlpool bath, that has been found very useful in military practice. My own practice is with ambulatory patients; others may treat patients with acute infectious fevers and acute infections of a medical or surgical nature.

Whether we bathe at the seashore or at spas, or take a course of baths at hydrotherapeutic establishments in cities, it is of prime importance to know the probable effects of such applications on the individual whether well or the subject of disease; not forgetting that a vast group who occupy an intermediate stage between good health and actual illness, a class that furnishes probably the greater proportion of visitors at our spas and health resorts. Without them, many of these resorts would close their doors. It will be convenient to note three phases of treatment from the standpoint of temperature in relation to body: (1) Plus applications of heat; (2) plus applications followed by minus; (3) minus applications (R. Fortescue Fox[4]). It will be noticed that there is no provision for heat after cold; it would

reverse the rational order and check the cultivation of the reactive powers of the body—powers which may be very limited indeed, especially in sickness, but yet capable of development and training just as muscular or mental faculties can be trained. This power of response to applications of heat and cold and the production of secondary consequences in the entire organism are, as Fox well says, the whole key to hydrotherapy. Dr. Simon Baruch[1] laid great stress on the same principles under the name of neurovascular training. We speak of baths and associated measures as educational; they draw out and develop dormant powers just as education, in the usual sense, draws out the mental and moral faculties.

## THE DRIP SHEET.

This is one of the simplest and most useful measures. The only things necessary are a tub holding 10 or 12 inches of water at 37.7° C. (100° F.); a bucket of water at 23.8° C. (75° F.); a sheet; and an attendant. The patient stands in the warm water to prevent chilling, and the temperature of the room should not be less than 21° C. (70° F.). The sheet *dripping* with the water from the bucket is quickly applied to the shoulders and back. The attendant should hold the greater portion of the sheet, gathered into folds, in his left hand; the right hand holds the right-hand border of the sheet; after plunging it in the water he applies the upper edge of the right-hand border of the sheet under the right axilla; the patient holds his right arm firmly to his side, thus holding the sheet, while he turns to the left and winds the dripping sheet about him. When wholly covered from the neck down it is tucked in at the neck and about the legs, and vigorous friction is made, with slapping of the hands upon the surface. A dipper of water from 10° to 15° below that used in the sheet is poured over the head and shoulders two or three times, alternately with frictions of the body. The entire process should then have occupied five or eight minutes. The sheet is then withdrawn; the patient is dried with soft towels, and friction is used with a warm sheet or towel to promote the hyperemia of the skin. A good deal of heat is abstracted in this process, and, while refreshing, it may be somewhat fatiguing when first applied. If the condition of the patient and the weather permit, it is a good plan to go out for a short walk. The bath is tonic, especially suitable for neurasthenia, hypochondria, melancholia, or for patients with anemia or pulmonary tuberculosis. From three to five minutes would probably be better at the outset in the latter affections. Only when antipyretic effects are desired are the longer periods, ten to fifteen minutes, required. In the latter baths the tonic effect is lost and the sedative action is more prominent. The temperature of the water used for the drip sheet may be lowered 1° F. each day until 12.8° C. (55° F.) is reached.

### THE COOLING WET-SHEET PACK.

A linen sheet saturated in water at 21° C. (70° F.) should be wrung out slightly and wrapped about the patient, carefully applying closely to the body and around each limb, and snugly about the neck. The patient may be covered lightly. In a few minutes, as the sheet warms, a second sheet, similarly prepared, is applied in place of the first one, and so on until five or six applications have been made at intervals of five minutes. Friction with the hand outside the sheet promotes cutaneous circulation, and the temperature of the febrile patient may fall 1° F. or more.

This pack is modified by opening up the sheet and sprinkling the body and the sheet with a sprinkling-can holding water at 4.4° to 7.2° C. (40° to 45° F.), allowing the patient to turn slightly to receive it on either side.

In giving a wet pack to a child or infant some modifications are necessary. Over a rubber sheet is placed a pad or thick flannel blanket on which the child is to rest. After removing all clothing the body is wrapped in a thick bath towel, which has been moistened with water at 32° C. (90° F.). The legs and arms are allowed to be free. He is then covered with two or three thicknesses of blankets. The temperature is taken in one-half hour. If no reduction has taken place the towel is moistened without removing the child, with water 5° or 10° F. cooler. It is not usually necessary to use water lower than 26.5° C. (80° F.). If the patient's temperature is reduced to 38.3° C. (101° F.) the pack is removed and reapplied when required. In pneumonia occurring in infants and children this process is particularly suitable. The pack adds to the child's comfort, improves sleep, lowers the respiratory rate and strengthens the heart.

### EVAPORATION BATH.

Place a mackintosh and blanket under the patient. Cover the patient, both extremities and trunk, with one thickness of gauze moistened in water at 46° C. (115° F.). Have the gauze fit the skin snugly. Fan the patient with a palm-leaf fan, and moisten the gauze, as evaporation takes place, with water still at 46° C. (115° F.). One pint of water should be evaporated in fifteen minutes. A hot-water bag is placed at the feet and a compress on the forehead. To keep the water at 46° C. (115° F.) this basin should be placed in a larger one containing water of a higher temperature.

### THE COLD RUB.

A coarse linen sheet is soaked in water at 15.5° to 21° C. (60° to 75° F.), and wrung out so as to hold less water than in the case of the drip sheet. It is wrapped around the patient; rapid friction is made,

so as to redden the skin. After this the sheet is dropped and the patient is then dried with a coarse towel and after dressing goes out into the open air.

## THE COLD BATH.

The best time for the cold bath in fairly vigorous persons is before breakfast. Weak or delicate persons may take it in the forenoon. Chill, languor or drowsiness coming on after the baths, are counter-indications to their continuance. Tepid baths are then preferable. The water of the cold bath is usually drawn in a tub from the public supply, and varies according to the season from 4.4° to 24° C. (40° to 75° F.). The cold bath is the favorite bath of the Anglo-Saxon race. Every one is familiar with the determination with which the Englishman, wherever he is, insures his morning cold bath, and undoubtedly it has an influence in promoting his vigor and his well-known appearance of health. The cold bath is counterindicated in advanced life and at any age when arteriosclerosis exists. Cardiac weakness, emphysema and bronchitis in such cases are better treated by hot sponge baths.

When water is used for defervescent purposes it is wrong to begin with a too low temperature, to use too little friction and to employ the bath for too short a time. In severe acute diseases the action of the water cannot be judged exclusively by its effect upon the temperature.

## THE SO-CALLED "HALF BATH."

This is really a shallow bath, the water reaching to the umbilicus, but its application involves the whole surface of the body. It is a powerful tonic when applied with water at 18.3° to 22.1° C. (65° to 75° F.), and should occupy from three to five minutes. The tub is filled to a depth of 5 or 6 inches. The patient should enter from a warm bed or his circulation should be stimulated by exercise. As soon as he enters the water he rubs his limbs, while the attendant rubs the chest thoroughly for a few moments with both hands and then takes the limbs in turn. The attendant repeats the rubbing of the various parts quickly once or twice more. The shallow water enables the attendant to get at the various parts more readily than in the full bath.

The half bath, or shallow bath, is useful in cases of anemia and in many chronic diseases of the spinal cord. It is useful in cardiac affections and usually suitable for asthmatic patients who are oppressed by the Turkish or Russian bath. It is useful in chronic affections of the stomach and in constipation. At the higher temperatures it is suitable for cases of sciatica and all painful affections of the lower extremities and pelvis.

## SPRAY BATH.

Technically, the spray bath, designated by French clinicians, *bains a l'hydrofere*, consists in applying to the skin of the patient a continuously fresh layer of water in a finely divided state. A specially devised spraying apparatus is used which affords a strong mechanical impact to the skin, exerting a marked sedative effect on the nerves, removing secretion. Mineral waters with gaseous and solid contents are used in this way at European resorts.

This is practically a douche of very fine streams issuing from a large perforated hose nozzle attached to rubber tubing, and may be applied horizontally or in any other position.

The spray bath is eminently suitable for treating sunstroke. The patient should be stripped and put on a cot covered with a rubber sheet and an ice-cap applied to his head. The water is applied from the nozzles in a fine spray, at the lowest temperature afforded by the public supply or from a supply cooled to a temperature of 13° to 15.6° C. (55° to 60° F.). When the rectal temperature reaches 39.4° C. (103° F.) he may be wrapped in blankets and made comfortable in bed, the process being repeated if the temperature rises, and in subsequent baths it may be possible to reduce the temperature to 38.3° C. (101° F.).

## DOUCHES.

Douches may be applied to individual portions of the body, so that particular organs or other structures may be affected. The rain or shower jet, the spray, the fan or the filiform douche may be chosen, as the parts require, and they may be short, prolonged, hot or cold, or alternately hot and cold, and under greater or less pressure—from 10 to 35 pounds to the square inch.

Cold applications lasting one or two minutes are strongly stimulant, producing a vigorous reaction in most cases. The entire vascular and lymphatic system immediately underlying the exposed parts are affected in proportion to the pressure under which the douche is applied.

Hot applications allay pain or benumb the superficial cutaneous nerves. At a temperature of 32.2° to 37.8° C. (90° to 100° F.) they produce local and reflex sedative effects (Figs. 1 and 2).

Rain or shower baths may be connected without very much expense with the supply of the ordinary bath tub. They are supplanting the tub baths in the municipal bath houses. The descending rain douche, in brief application and moderately low temperatures, causes a vigorous nerve stimulation and strong reaction. It accelerates metabolism and promotes the circulation. It is especially applicable in nervous affections, functional disorders, such as neurasthenia and hysteria, neuralgia, paresis, disorders of nutrition, and in weak circulation when no organic changes in the heart and bloodvessels are

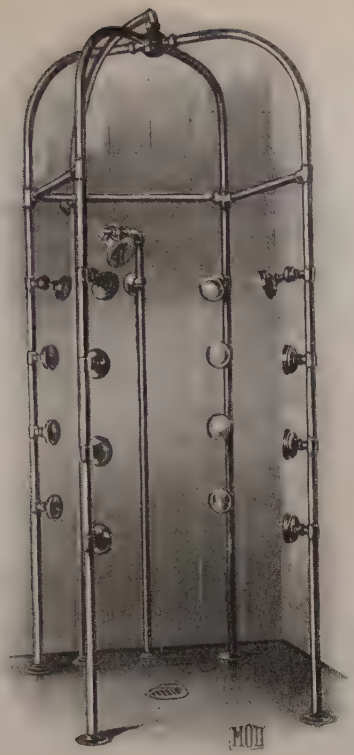

FIG. 1.—Combination needle bath, rain-shower and spray baths.

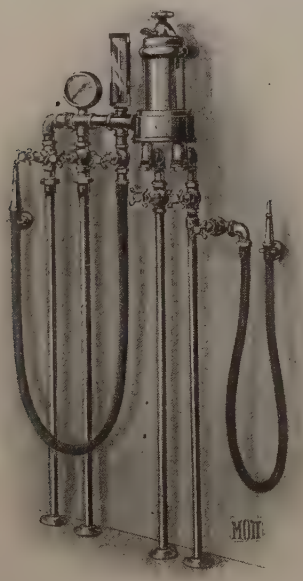

FIG. 2.—Hydrotherapeutic control outfit for the Schott douche, needle bath, and rain showers.

present. It has marked influence on heat production and sweat formation, for which somewhat longer applications are required. Tepid and warm rain baths have a sedative action and are applicable, therefore, in very sensitive neurasthenic and hysterical subjects. Changing the temperature, now warmer and now colder, then quite warm, accomplishes much in torpid conditions and enforces a good reaction, especially in anemia and chlorosis, because a good nervous stimulation is brought abou without heat abstraction. Rain baths favor the action of the skin, and are applicable in many of its affections. In adjusting the shower, the spray should not be allowed to fall vertically, but at an angle. It is not necessary or desirable that all the water used should fall directly on the head.

**Cold Douche.**—This is a single stream of water under pressure, coming from a nozzle of $\frac{1}{4}$- or $\frac{1}{2}$-inch aperture, at a distance of 6 to 10 feet from the patient. The temperature may be regulated by valves which govern the mixing chamber, and may be graduated from 24° C. (75° F.) down to the coldest water supplied. It is a powerful stimulant, and useful for a tonic effect after the hot-air bath and circular douche. It is counterindicated in asthma. Paroxysms of asthmatic breathing may be induced. The sudden contraction of the pulmonary vessels restricts the area of blood subjected to oxidation in the lungs. The carbonic acid is not properly eliminated, and a sense of suffocation ensues. This is corrected as reaction occurs, and the secondary effects are powerful, tissue change being highly stimulated. Fatigue gives place to renewed energy, especially if the cold applications are preceded by heat and followed by vigorous rubbing.

**Kneipp Water Cure.**—Cold douches were the mainstay of the famous Father Sebastian Kneipp, a Bavarian priest.[5] He and his assistants applied this usually to the lower limbs, and he also ordered his patients to walk barefoot in the morning dew on soft grass and adopt a spare diet. Many thousands of people from all over the world were treated in this manner twenty years ago with surprising results. Accompanied by suggest on and good circulation induced by this form of treatment, which included early morning exercise, a great amount of good was undoubtedly accomplished.

**Substitute for Jet Douche.**—In the absence of apparatus for the jet douche a substitute may be adopted. The patient on rising stands in a bath tub and turns the two faucets so that the water will be delivered at about 37.8° C. (100° F.). A large bathing sponge is held under the faucet and then pressed against the back of the neck. This is done several times, and the hot water having been turned off, the sponge is filled with cold water and applied to the back of the neck and spine in the same way. After a brisk rubbing the patient partly dresses and lies down for one-half hour.

*Uses.*—Cold douches, whether locally or generally applied, preceded by some warming measure and followed by friction, are used for anemia, insomnia and headaches. Acne of the face and thorax,

and a generally bad complexion are also improved by these measures, as are also chronic constipation with muddy complexion, general autointoxication and general malnutrition.

**Spinal Douche.**—Charcot used the spinal douche at a low temperature, 72° to 15.6° C. (45° to 60° F.), in cases of hysteria with marked benefit. It was never applied except to a limited portion of the spine, and hence no general depression occurred and the reaction was easy. The limited spinal douche at 20 or 30 pounds' pressure and at low temperature is sometimes referred to under Charcot's name.

**Aix Douche.**—This is a combination of a warm douche with vigorous massage; it may be given by one or two attendants. It is rather too strenuous a measure for most patients, but may be used in refractory cases of gout or rheumatism.

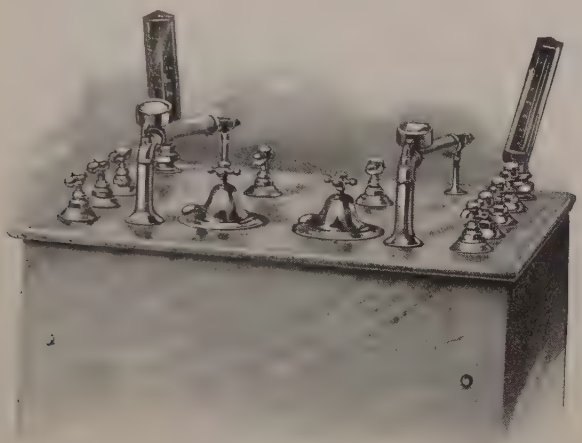

Fig. 3.—Baruch type of Italian marble Scotch douche control talc.

**Alternating Hot and Cold Douches (Called the Scotch Douche).**—Alternating hot and cold douches (Scotch douche) produce distinctly exciting effects. They are not applicable to the head, the anterior chest or the abdomen, but may be applied to the spine and posterior thorax and to the lower extremities. With temperatures alternating between 40.5° and 21° C. (105° and 70° F.), or possibly a few degrees lower, good results are obtained.

In applying a douche to the head it should be, as a rule, cold or cool, without pressure, as given from a dipper or pitcher, and the duration only a few seconds. The immediate effect is a dilatation of the blood-vessels of the brain; if too long continued a secondary contraction and chilling occur; it may be designated as an affusion, and is used in connection with the Brand bath, always at a slightly lower temperature, and repeated once or twice. It may be applied in mental disease, as in melancholia and hypochondria. In cases of insomnia, mania and paresis the water should not be less than 26.5° C. (80° F.) or more than

35° C. (95° F.). Douches to the head are generally inapplicable to women on account of the difficulty of drying the hair. For women the full bath or the spinal douche is to be preferred. Great caution should be exercised in any case (Fig. 3).

## THE WHIRLPOOL BATH.

Dr. Curran Pope, of Louisville, Ky., has kindly contributed the following on the whirlpool bath.[6] "This bath is a direct outgrowth of the great World War, having its original inception in France in the so-called 'current baths.' Dr. Fortescue Fox, of London, further

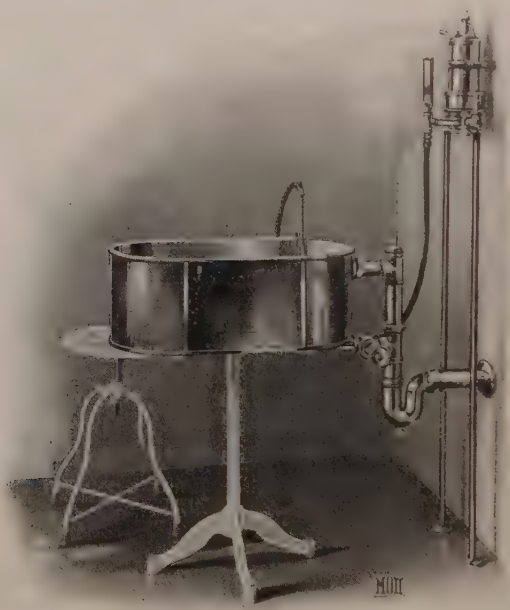

Fig. 4.—Whirlpool bath; arm section.

amplified the current bath and increased the whirl that constitutes the essential features of the bath. From the best information at my disposal the present simple and perfected bath was finally worked out in this country at the Walter Reed Hospital.

**Apparatus.**—Usually two baths are employed—one for the arms, the other for the legs. They consist essentially of the tub portion and the aërator. The tub used for the lower extremities is ovoid in shape, and of sufficient length and depth to comfortably encase the lower extremity to as near groin as possible. The arm tub rests on a stand oval in shape, long and deep enough to receive the arm as high as the axilla, or at least to the middle of the arm. The 'aërator' (Figs. 4 and 5) is simple and automatic. When assembled it is a unit

with two principal parts, as shown in the illustration, one supplying air, the other water, so arranged as to mix the air with the water. It consists essentially of two tubes—one anterior, the other posterior. The anterior tube carries the air, the posterior the water. When put together the anterior, or air carrier, fits *over* the posterior, or water carrier, at the basal or lateral portion, the tapered point of the water tube being within the air tube. The two parts are attached together by threads. The upper portion of posterior or water tube is bent at right angles backward and terminates in a fitting with an ordinary heavy thread, such as is used on garden hose. The water supply for the aërator is brought from the supply to the bath by a rubber hose

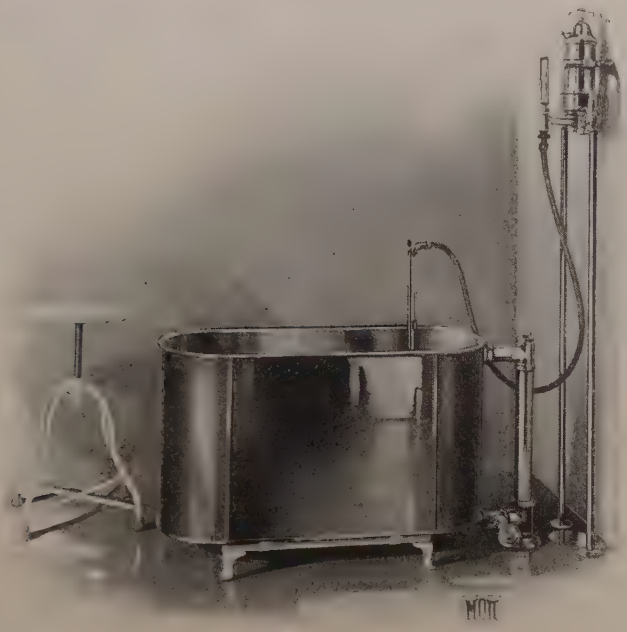

FIG. 5.—Whirlpool bath; leg section.

(preferably $\frac{3}{4}$- to $\frac{7}{8}$-inch stream). On the end of this hose is a screw attachment that fits the threaded terminal of the posterior tube of the aërator. The anterior tube is well above the level of the water and remains open to the air.

**Technic.**—Very little water flows through the aërator at any time. To prepare the bath, therefore, the rubber hose must be unscrewed from the posterior tube and the tub can be rapidly filled with water of the required temperature. It is best to commence with a lower temperature. The water is then turned off, the hose reattached and the valve opened so as to permit water of a certain temperature to flow through the aërator. The pressure should range between 15 and

30 pounds and the temperature should commence at 43.3° C. (100° F.) and be rapidly raised to as hot a temperature as can be borne. By starting with low temperature and gradually increasing the higher temperatures can be more readily endured. After a few baths tolerance to heat seems to be acquired. The bath tub having been filled, the patient, wearing a bath robe, takes his seat upon the bench, just trifle higher than the top of the tub, or on an adjustable metal stool and immerses the naked limb in the tub. Water of the desired temperature is now allowed to flow through the water tube of the aërator, passing through the fine-pointed nozzle. As a result there is created a suction in the air tube of the aërator and the air of the room is drawn down to the bottom where it meets the outcoming stream of water. The water and air are both forced out of the aërator exit by the water pressure, producing a swirling or whirling stream that causes the water in the bath to become agitated. If the exit of the aërator is turned a little to the right or left the agitation assumes a spiral movement. It will be readily seen then that the limb is enveloped in a hot continuous bath, the water of which is stirred in a spiral manner by the hydroaëratic pressure. The water flowing through the aërator should be as hot as can be borne, and should gradually raise the temperature of the bath until the maximum tolerated temperature is reached. My personal experience covering a period of six or seven years is that the hotter the bath, the better the results obtained. It will be found that some cases stand 48.9° C. (120° F.) or even higher temperatures, though this is rare. The duration of the bath varies from five to forty-five minutes; averages, twenty minutes. It should be administered in the beginning every day, later three times weekly and its subsequent use as frequently as may be demanded in the judgment of the hydriatrist.

**Physiological Action.**—When the limb is immersed in the hot water in the tub, and the whirl commences, the water seems to be hotter, although the actual temperature has not been raised. The most pronounced action of this bath is upon *the arterial circulation*, dilating the vascular areas of the extremity to a marked degree. The limb assumes a much redder, flushed appearance in the whirlpool bath than does a control limb in a bath of similar temperature without the agitation from the aërator. Patients state that the limb seems fuller and heavier. I have measured limbs as accurately as I can in a clinical test, and am convinced that the circumferential measurement is increased often from $\frac{1}{2}$ to $\frac{5}{8}$ inch. This redness remains much longer after this bath than under ordinary immersion. That the venous return and lymphatic activity is greatly accelerated is beyond question. The combination of the heat, the mechanical and neural stimulation that comes from the impact of the air bubbles, tends to break down all hardened inflammatory deposits, relax muscular structures, loosen joints, soften ligaments and increase venous activity and the return of the blood to the general bodily circulation.

Upon the *nervous system* its effect is most pronounced. After a very short time the sensation in the limb is lessened to such an extent that the limb has a numbed or anesthetized feeling. If the limb is the site of pain this is relieved in a remarkable number of cases. It is interesting to note that limbs that were so tender they could hardly be touched can usually be handled and gently massaged, with freedom from excruciating pain that was present before the immersion in the bath. In fact, traumatized nerves, joints and muscles can be prepared for massage by the use of this bath. It is a powerful nerve sedative and produces a peculiar sensation of comfort. Tests of epicritic sensation (by Head's methods), especially the pain sense will show a distinctive difference between the immersed and unimmersed limb. To the touch the skin feels hot and soft and, as before stated, the size of the limb is plainly increased to vision. It quickly relieves spasm in the muscles and relaxes joints. The tissues feel soft and pliable. It is a common experience that after the bath, contracted muscles and stiffened joints can be moved, stretched and manipulated with more ease and less pain. In traumatic and other surgical cases, whose cuts, sores and other injuries have healed, it is not uncommon for the extremity to show *vasomotor* (blueness, coldness, subnormal temperature), *trophic* (shiny and rough skin, atrophy, etc.), and *joint* (pain, stiffness, swelling, immobility) disturbances. As a result of the bath and the resultant increase of circulatory and other activities, these defects are modified, and eventually removed if they are capable of relief. The bath *per se* an efficient form of gentle massage, especially valuable to tender and sensitive limbs and in cases where treatment cannot be applied in a mechanical way because of the difficulty of manipulation, massage or surface treatment, this bath furnishes an ideal modality. In these cases the limb may be at first treated in a 'neutral' temperature, 33.3° to 35.6° C. (92° to 96° F.).

The *antibacterial activity* of this bath has the same basis as any superheating process. It is generally accepted that many microorganisms can live and propagate only within a limited range of temperature. It is well known that pyrexia is in a sense a curative measure, in that the rise of bodily temperature tends to destroy the activity of the invading organism. Raising the temperature of a limb from 10 to 15° F. above the normal blood temperature inhibits the growth of bacteria. If the temperature best suited for their growth is 'blood heat' any decided rise in temperature, as in the limb, would correspond to a pyrexial reaction and tend to destroy the germ and immunize the patient. Thus localized infections would be removed, not alone by destruction of the invading microörganisms, but also by all the vascular, trophic and immunizing processes that are incident to this bath and the pyrexial processes that accompany it. Care should be exercised in the treatment of those limbs, the seat of severe injuries, especially where there are areas of anesthesia or marked trophic states.

**Therapeutic Application.**—The whirlpool bath is one of the most powerful of the physical curative measures in hydrology for those lesions involving the areas that can be treated. Its heating properties relax the limb, flood it with arterial blood and stimulate the venous circulation to greater activity; relaxing the contracted, swollen, stiffened and spasmodic muscles, sedating the peripheral nervous system, preparing the limb for any electrical treatment by increasing its conductivity and rendering it more amenable to mechanical measures, such as manual or mechanical massage, vibration, manipulation and passive exercise.

In spite of its anatomical limitations it has a wide field of usefulness. In *inflammatory processes* of all kinds, irrespective of cause, it reduces the activity of the process. Owing to the rise in temperature of the limb, both superficial and deep, it is bactericidally effective, it being a well-established principle that above certain temperatures microörganisms are destroyed, notably staphylococci, gonococci and tubercle bacillus.

In *chronic edema, synovial* and other effusions the increased activity of the vascular system, the metabolic changes and neural influences, especially if the bath is followed by massage, render it wonderfully effective. In fact, any condition in which the circulation has become affected and in which stasis is a factor is benefited.

In *muscular states* accompanied by inflammation, hardened inflammatory deposits, spasm and spasticity the relaxing, absorptive and pain-relieving qualities make it one of the most rapidly remedial measures at our disposal. When followed by diathermy the action of the bath is enhanced and relief more quickly obtained.

In *bony lesions,* such as swellings of the periarticular tissues, deposits of callus, old fractures, periosteal and bone inflammation, tubercle and syphilis, all come within the province of the therapy of this bath. It has been my experience that other therapy, vaccinal, seral, chemical (drug) is enhanced, and better local effects produced when used in conjunction with the whirlpool.

All forms of *nerve lesions,* traumatic, infective, trophic and nutritional, where accompanied by pain, spasm, hyperesthesia, etc., yield to this form of therapy. In neuritis vera, partial and complete peripheral paralysis, in those nutritional lesions, the result of long-continued, suppuration and infection, cases, often the *bete noir* of medicine, generally respond, although great care must be exercised and at the start the hydrologist should personally supervise the administration of the first few baths.

Nothing in the field of medical therapy has proven so satisfactory in the treatment of *cicatrices* as the whirlpool bath followed by ionization by the negative pole of the galvanic current. Painful, adherent and contracted scar tissue, under the softening, relaxing and often absorptive action of this bath and galvanic current, are relieved and parts long hampered, are made efficient and useful and again function-

ate in a proper manner. Skilful manipulation with a highly trained *tactus eruditus* hasten the effectiveness of hydrological therapy.

Upon *ulcers* and *chronic suppurative wounds* this bath cleanses the surface, assists in separating dead and useless tissue, increases the circulation and nutrition of the part and promotes healing. It becomes doubly effective if due attention is paid to the endocrines and calcium metabolism.

In the *arthritides* it has a wide field and is but rarely employed. The writer believes that *rheumatism* is but a name to cover diagnostic and therapeutic ignorance, yet in the so-called rheumatic diseases it occupies a unique nitch. Arthritis in its active and infective stages, arthritis in its postinfective and mechanically crippling period, gout, myositis, neuromyositis, stiff, swollen, enlarged and tender joints are all given relief that can be obtained from no other therapy. The writer feels justified in this statement. In his private hospital he has available every form of physical, chemical, bacterial and other therapies and feels that many cases of this kind would have failed of relief had it not been for this form of hydrological therapy.

As a preliminary to other therapy the whirlpool bath in diseases and disorders of the extremities is surpassed by no other measure. It not only makes manual and mechanical massage, stretching and manipulation possible but reduces the time required about 70 per cent, a factor to be considered where many are to be treated. The writer has often noted in the limb treated results closely resembling the effects produced by the Nauheim bath. He has experimented with these aërators, using them in a full bath, and believe their physiological action upon the heart and circulation is not unlike that of the Nauheim bath. In conclusion it may be said of the whirlpool, as of hydrology in general, that in America its employment in a scientific manner is extremely limited and in a number of instances haphazard. This is indeed to be regretted, as it is a therapeutic method of wonderful flexibility and usefulness. (Curran Pope).

## SPONGING.

Before sponging a patient note first the exact temperature. Have water ready at between 26.7° to 32° C. (80° to 90° F.). Remove all clothing from the patient and have blankets over and under him. Put the basins, sponges, towels, etc., on a table nearby, so that it will not be necessary to leave the patient for any reason whatever. Commence at the head and sponge downward, exposing only one limb at a time. When the whole body has been sponged the patient should be wrapped in a warm blanket, and left undisturbed for an hour or longer. The temperature should be taken at the end of each sponging.

Cold sponging is better borne by sensitive patients if there is a preliminary sponging with tepid water—26.7° to 32° C. (80° to 90° F.) —before applying the water at 15.6° to 21° C. (60° to 70° F.). A hot

bottle at the feet during sponging is comfortable to the patient, and may ward off a chill or tendency to collapse. After sponging, the body is to be dried and a nightgown put on.

### AFFUSIONS.

These are used in connection with the half bath, the Brand bath or as an independent measure. They are decidedly stimulant, and hence are valuable to rouse the unconscious patient. In cases of *sunstroke* they are remarkably successful. The patient, stripped or covered with a sheet, is placed on a cot protected by rubber. Dipperfuls of very cold water are then forcibly dashed on the patient from a distance of several feet. In severe cases a small stream may be allowed for a few moments to fall on his forehead. This is to be repeated every two or three minutes until the temperature falls to 39.5° to 40° C. (103° to 104° F.), when he patient is wrapped with blankets and surrounded with hot bottles. The latter is a complementary feature of the affusion, for sweating will probably ensue after a short interval in the warm pack, and the restoration of this function saves the patient.

### THE WARM FULL BATH. CONTINUOUS BATH.

A large tub is filled three-quarters full, and the patient enters and is fully immersed. His head is covered with a cloth wet in cold water. The room should be at a temperature about 26.5° C. (80° F.), and means should be at hand for maintaining the water at its initial degree of heat, as this bath is usually prolonged to ten, fifteen or twenty minutes or more, as required. Indeed, the duration of the bath was extended by Hebra, Zuschlag and others to days and even months, the patients, some of whom suffered from extensive burns, bed sores, pemphigus and other skin diseases, existing in the continuous bath for remarkably long periods. If continued for several hours the patient may sleep in the bath, but he naturally requires constant attendance and special lifting apparatus and electric and other appliances for maintaining a constant temperature. For surgical and dermatological purposes 35° to 37.6° C. (95° to 100° F.) is considered best. Mutton suet, lanolin or petrolatum applied thoroughly to the skin protects it from puckering and peeling (Fig. 6).

In formidable diseases like pemphigus, Kaposi showed that it relieves pain, reduces fever and enables the patient to pass over the period of eruption when otherwise he might succumb.[7]

*Prolonged warm baths* are suitable for cases with bed sores, compression, myelitis, locomotor ataxia and paraplegia, with paralysis of the bladder and bowels, inoperable cancer of the urogenital tract, obstinate cases of sciatica and muscular and articular rheumatism. They have been advocated for chronic meningitis, hemiplegic contractures and general hyperesthesia.

Hebra, Jr., in 1877, reported upon 203 cases of various kinds treated by the continuous bath. Among these were 120 of severe burns of which 71 died and 56 recovered. Excellent effects were noted in the relief of pain and the avoiding of infection, lymphangitis, pyemia, etc. Suppuration was slight, new skin rapidly formed and the scars were better than under other treatment. Nine cases of pemphigus vulgaris were cured, and in 6 cases of foliaceous pemphigus life was prolonged and suffering materially alleviated. In 1 case of confluent smallpox, complicated by pneumonia, the five- to seventeen-day bath was applied; there was only moderate fever, the fever of suppuration was

FIG. 6.—Continuous bath, flowing constantly, as used at the Beaumont General Hospital, San Antonio, Texas. Case of fracture of the ninth, tenth and eleventh dorsal vertebra. Treatment can be continued for months, without removal from bath.

barely noticeable and the scars were good beyond all expectation. Twenty-five gangrenous buboes out of 28 were healed, improvement appearing immediately after the treatment was inaugurated. Phagedenic chancres, phlegmon, gangrene of the skin and other conditions were included in this series, and they were all serious cases. Riess reports remarkable improvement in cases of bed sores, which occurred on patients suffering from disease of the spinal cord, and, further, made the unexpected discovery that the original disease underwent great improvement.

The various forms of meningitis, paralysis, delirium and nervous

agitation are stated to be amenable in some degree to the influence of the continuous bath, as well as obstinate sciatica and hysteria. Acute psychoses, epilepsy and alcoholism have been treated with it with good results. Maniacal excitement responds to it with almost absolute certainty. No form of restraint should be permitted in the tub; an attendant should be constantly in attendance. The benefits of the continuous bath are summarized as follows:

1. It acts as a sedative upon the central nervous system.
2. It influences circulation in the sense of disincumbering the inner organs and diverting the blood toward the skin.
3. It favors the nutrition and healing processes in the skin.
4. It augments heat withdrawal.
5. It accelerates metabolism.

The continuous bath is an exceedingly effective remedy and, though apparently troublesome to administer in some respects, succeeds where other less laborious methods fail.

*Warm baths of short duration* are valuable in all febrile affections in infants and young children, in cerebrospinal meningitis and in acute mania and other excited nervous conditions. They exert a decidedly corrective calming effect; the pulse becomes softer and less frequent; the respiration falls in rate. The peripheral arteries are dilated and peripheral sensibility is blunted. Cases of atheroma, angina pectoris and other cardiac cases are not proper subjects for the warm bath.

Warm baths of one-half hour's duration are very useful in amenorrhea and dysmenorrhea. In the latter case the temperature may be raised to 43.3° C. (110° F.).

Generally speaking, warm baths should be taken at night, just before retiring. To submerge the body in warm water relaxes the muscles, takes the blood from the head and equalizes the circulation. This is a good preparation for sleep, physically and mentally, especially if it is not followed by vigorous rubbing. Hard rubbing stimulates the nerves of the skin and may cause wakefulness.

## HOT-WATER BATHING.

Hot-water baths between 37.8° to 46° C. (100° to 115° F.) vary in their effects according to the temperature and duration. Usually it requires a gentle gradation in successive baths to withstand baths of 40.5° C. (105° F.) or over, and people vary greatly in their sensitiveness to hot water. Different parts of the body vary in this respect—the feet, for instance, being much more sensitive than the hands.

The Japanese practise hot-water bathing more than any other people. It is said that they usually have the water at about 54.4° C. (130° F.). The head is bathed in hot water before entering the bath, which is prepared in wooden tubs, a common sight in Japan, where in Tokio alone upward of 400,000 hot baths are given daily. The temperature of the body rises to about 40° C. (104° F.) in the course of

six to eight minutes, but returns to normal in about one-half hour. Cold affusions are applied after the bath. This custom is common to all classes of Japanese.

## THE TURKISH BATH.

Well-equipped establishments are found in the larger cities. The objects to be attained by the Turkish bath are varied. As a hygienic measure the public employs it extensively without medical advice, and usually with decided benefit. Its effects are cleansing, refreshing and stimulant to the circulation. It hastens recovery from the effect of alcoholic excesses better than any other procedure. It favors elimination through the lungs and the skin, and tends to reduce excessive weight. After disrobing the patient places a loin cloth about his body, takes a drink of water, either hot or cold, and enters a room with dry air at a temperature of 44° to 54° C. (100° to 130° F.). After ten or fifteen minutes perspiration appears. After perspiration is established he enters a room at 65° to 93° C (150 to 200° F.) for a few minutes until perspiration is very free. After this the patient goes to a room with marble slabs, and, lying down, receives a rubbing with bare hands and finally a shampoo with soap. In this process bathers may use the loofah, or Egyptian fibrous sponge. Next the patient takes a cold douche at 15° C. (65° F.) or, if perspiration is still rather free, he should have a rain douche, the temperature being reduced in from one to three minutes from 30° to 24.1° C. (85° to 75° F.). The next step is the swimming bath with water at about 15.6° C. (60° F.) or the patient may lie down until the skin is dry and the pulse is normal.

The great stimulus to the sweat glands is the marked feature of the bath, and the secretion is increased ten-fold during the hour's treatment. By as much as the blood is drawn to the surface of the body by so much are the liver, spleen, stomach and intestines relieved of any tendency to stasis. The Turkish bath is indicated in the treatment of obesity, alcoholic habit, diabetes, chronic dyspepsia, the gout of corpulent persons; among neurasthenics and insane patients there are many who would be much better for Turkish baths; selected cases of neuritis and chronic myelitis may be treated in this manner. For anemia and chlorosis it is admirable.

**Counterindications for the Turkish Bath.**—In all cases of cardiac dilatation, tachycardia, arteriosclerosis, exophthalmic goiter, this bath should be avoided. Whenever, in cases of organic heart disease, there is deficient or failing compensation these baths may do harm. While some cases of nephritis are benefited, care must be exercised and the patient be under competent observation during their use. In advanced Bright's disease the Turkish bath is positively counterindicated.

The Turkish bath is counterindicated in skin diseases accompanied

by eruptions, on account of the excessive congestion of the skin induced. Vapor or Russian baths are preferable. They are to be avoided in cases with a history of apoplexy and in most pulmonary diseases.

### THE RUSSIAN BATH.

In this bath the patient lies on a marble slab in a small room filled with steam. He is rubbed at intervals by an attendant to hasten perspiration. The temperature of the room is lower than that of the Turkish bath, 46° to 49° C. (115° to 120° F.), and the duration ten to twenty minutes. The presence of steam renders higher temperature unbearable. After this the bather takes a shower of cold water, 15.5° C. (60° F.), or a plunge in a pool at the same temperature.

Sweating baths, on much the same principle, were formerly practised by some of the tribes of American Indians. One of their methods of treatment was the sweating bath. "These baths were literally earthen ovens, into which the patient crept and around which heated stones were placed to raise the temperature. When the patient had remained under perspiration for a certain time he was taken out and immersed in cold water."[8]

### TO APPLY THE VAPOR OR SWEATING BATH.

Place a blanket and mackintosh under the patient; then wrap him in a blanket. Place a cradle over the patient and cover it with mackintoshes, tucking them in well around the neck and fastening them securely at the bottom so the steam cannot escape. Put an ice-cap or cold compress to the head. A croup kettle or an ordinary teakettle with a long spout may be used to generate steam.

Let the steam come up gradually. Keep the patient in the bath for thirty minutes to one hour, as required. Watch the pulse at the temples, and face, and take temperature, pulse and respiration in the bath. Give plenty of water to drink. Tea or hot lemonade may be given.

### THE HOT-AIR BATH.

This is used as a preliminary treatment before applying douches. The entire body, with the exception of the head, is inclosed in a cabinet provided with steam coils. The head should have a cold turban, and the body may be surrounded with a sheet or not, as desired. The heat in these cabinets rises to 60° to 82° C. (140° to 180° F.), and, as a rule, free perspiration is produced in seven to twelve minutes. Portable cabinets for hot-air baths are sold at moderate prices by surgical instrument dealers (Fig. 7).

The superiority of the hot-air cabinet over the ordinary Turkish bath is evident. The patient is surrounded by hot air in the cabinet and, the head being free, he breathes cooler air. Not only is he thus enabled to bear higher temperatures, but he is free from dyspnea which

is so distressing to many in the hot-air chamber of the Turkish bath, and which is doubtless due to a defective supply of oxygen; the latter, being expanded by heat, is not breathed in sufficient quantity to fulfil its physiological function. If oxidation be the chief object of the hot-air bath the cabinet bath must be far superior to the Turkish bath, because it permits a more abundant supply of oxygen as regards the temperature, and thus facilitates oxidation.

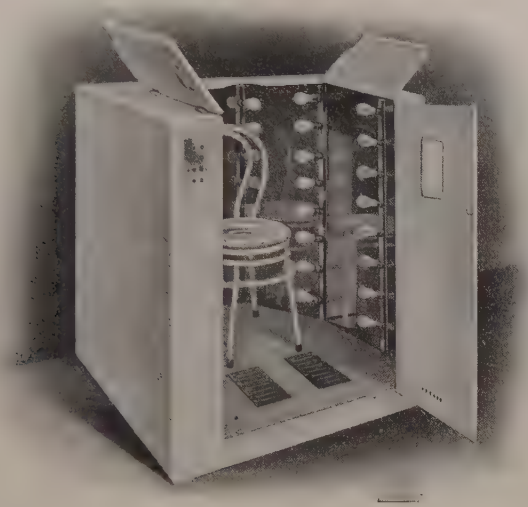

FIG. 7.—Electric-light bath cabinet, with enameled white steel chair.

## THE HOT-AIR BATH AND THE ELECTRIC-LIGHT BATH COMPARED.

The electric-light cabinet is safer, quicker in action and probably has a greater and more beneficial effect on the underlying tissues. It is common observation, but not always true, that perspiration ensues in an electric-light cabinet more quickly than in the hot-air cabinet.

The well-known penetrating quality of the electric-light rays probably aids metabolic processes in deeper structures.

In the hot-air bath the body is heated by a process of convection, successive layers of tissue being heated until the body temperature is raised 1° or 2° F.; but the rays from incandescent lamps, like the sun's rays, have a more penetrating power and stimulate normal metabolism.

**Moliére Bath.**—This is used at some institutions for the treatment of neurasthenic cases. It consists of an electric cabinet bath, with incandescent lamps and also an electrical attachment, supplying current to electrodes. The current passes from the sponge electrode at the back to electrodes on the soles of the feet. The lights are turned

on and perspiration ensues during the bath of ten to twenty minutes. There is a door in the back of the cabinet to admit of arranging the electrode. This bath, followed by a needle douche of two minutes at 41.1° to 42.2° C. (106° to 108° F.) reduced to 32.2° C. (90° F.), and this is followed by an alcohol rub.

### FOOT BATH.

The hot foot bath is the best and most important of the local baths. It is a popular method of treating a cold in its earliest stage, and is a valuable preventive measure. Hot water and a small tub or pail and an additional supply of very hot water to reinforce the heat of the bath are the only means required, although it may be desirable in some cases to add a little mustard, so as to invite the flow of blood to the feet and ankles. The temperature of the water may be gradually raised to 43.3° C. (110° F.), 46° C. (115° F.), or 49° C. (120° F.), and the duration may be ten or fifteen minutes. The depth may be 8 or 10 inches; after the initial chill of pneumonia it would be a proper procedure. Sprains of the ankle or foot, bruises, cramps in the leg, etc., are not only rendered much less painful, but hot applications prepare the way for massage and more permanent dressings.

### MEDICATED OR MODIFIED BATHS.

Sulphur baths may be prepared at home according to the following formula, which is sufficient for a bath of 30 gallons:

| | |
|---|---|
| Precipitated sulphur | 2 oz. |
| Sodium hyposulphite | 1 " |
| Dilute sulphuric acid | ½ " |
| Water | 1 pint |

The above ingredients should be mixed together, and then added to the bath. The following baths are occasionally ordered by dermatologists:

Bran bath—2 to 6 pounds of bran. This should be tied up in cheesecloth bags before being put in water.

Potato-starch bath—1 pound of starch.

Gelatin bath—1 to 3 pounds of gelatin.

Linseed bath—1 pound of linseed in bags.

Alkaline bath—2 to 10 ounces of sodium bicarbonate or 2 to 6 ounces of potassium carbonate or 3 ounces of borax.

Alum baths—1 pound (500 gm.) to each bath (1 to 1000 solution). These are used at the Johns Hopkins Hospital to prevent skin infections in the course of typhoid fever.[9]

**Warm Mustard Bath.**—A modification of the warm mustard bath has been used with great success in the bronchopneumonia of young children, and in the suffocative attacks which are marked in weak,

rachitic children. About 3 pints of warm water are placed in an open vessel and 1 pound of mustard meal is added and stirred until the thin mixture gives off the irritating fumes which cause smarting of the eyes. Then a linen cloth is taken of sufficient length to cover the child. This is saturated with the mixture, wrapped about the child, who is then covered with a woollen blanket reaching to the neck. After ten or fifteen minutes the child will complain of discomfort, and, as the wrappings are removed the skin shows marked reddening. The child is then washed in warm water and is placed in an ordinary warm wet pack and allowed to remain for one or two hours. This produces diaphoresis. After the pack the child is put in a warm bath, which is gradually cooled. He is dried and allowed to remain quiet the remainder of the day. One advantage of this method is that the irritating fumes of the mustard are not inhaled and that the reaction is more perfect.

## "NAUHEIM BATHS." CARBONATED BATHS. EFFERVESCING BATHS.

This form of bath depends on the presence of carbon dioxide with other chemicals, principally sodium chloride and calcium chloride in various degrees of solution. The natural baths are given *par excellence* at Bad Nauheim, in Germany, near the southern foot of the Taunus Mountains. The class of cases for which the treatment is sought renders it all the more desirable that the forms of treatment practised at Nauheim be provided, if possible, at home. Aside from the associated forms of treatment, such as resisted (Schott) movements, graded walks, diet regulations and the benefits of climate, the baths are given at Nauheim according to a gradual increase in strength as regards solid and gaseous contents. This is a distinguishing feature. The temperatures of the three springs used at Nauheim are 29.5° C. (85° F.), 32.5° C. (90° F.), 35° C. (95° F.). The duration of the baths are as follows:[10]

The first and mildest type, the so-called *thermal baths*, are obtained by admitting the water to large open reservoirs where, in contact with the atmosphere, the $CO_2$ escapes and the calcium and iron salts precipitate. These salts color the water yellowish-brown.

The second type, containing a little more $CO_2$, is the *thermal sprudel baths*, and is obtained by conducting water to subterranean air-tight tanks from which it is conveyed to bathing tubs. This water is clear or slightly yellow, owing to its having lost but a proportion of its $CO_2$.

The third grade, or effervescent type, is known as the *sprudel baths*. They contain the full amount of $CO_2$. In their nascent state the waters contain from 550 to 1300 cc. of $CO_2$ to the liter, but, of course, much of this instantly escapes as soon as the water reaches the tub. These baths are strongly effervescing, bright, sparkling and clear as crystal.

Clear brine baths, containing 3 per cent of chlorides and no gas, are also used.

*Artificial Nauheim baths* are used, but not to the same extent as they were twenty years ago. Some advantages are claimed for them by those who have taken the trouble to apply them in selected cases, according to a definite scheme of gradation. Dr. Thomas E. Satterthwaite and Dr. C. N. B. Camac, of New York,[11] Dr. J. M. Anders and Dr. S. Solis Cohen, of Philadelphia, have endeavored to place this form of treatment on a definite and effective basis[12] (Fig. 8). The necessary salts can be obtained in convenient form in the shape of cakes of acid sodium sulphate, and they are far preferable to the hydrochloric acid which was previously used for the acid element in the bath. The latter is liable to destroy the tubs and injure the patient.[13] If the

FIG. 8.—The Nauheim bath; manometer control valve and carbonic-acid gas tank.

prepared salts are not accessible the elements may be prepared as follows: Take sodium carbonate, 1½ pounds; sodium bicarbonate, ½ pound; calcium chloride, 3 pounds; sodium chloride, 2 pounds. Mix and dissolve in the bath and add slowly the acid sodic sulphate, 1 pound, which should be kept by itself. This gives a bath of moderate strength. The box of Cassebeer Nauheim salts contains 8 disks of acid sodic sulphate, wrapped in heavy lead foil, and 4 packages, 1 pound each, of sodium bicarbonate. The method of preparing the bath is as follows: Fill a porcelain or enamel tub with 50 gallons of water at 40.5° C. (105° F.). The required amount of bathing salt then added. This, in an ordinary Nauheim bath, should consist of from 2 to 3.5 per cent of a mixture of sodium chloride and calcium chloride.

Dr. Satterthwaite has formulated an excellent scheme for the six weeks' course of 35 graduated baths, which will prove useful in practice.

*First week* (No. 1 bath): One-half per cent plain warm salt bath (2 pounds of bathing salt to 50 gallons of warm water). Temperature, 36.7° C. (98° F.). Duration, four minutes. Intermission on the third and sixth days of this week.

*Second week* (No. 2 bath): Three-fourths per cent warm salt bath (3 pounds of bathing salt to 50 gallons); 0.25 per cent carbonic-acid gas (2 disks acid sodic sulphate to 1 package, 1 pound, sodium bicarbonate). Temperature, 36° C. (97° F.). Duration, six minutes. Intermission on the fourth day of this week.

*Third week* (No. 3 bath): One per cent warm salt bath (4 pounds of bathing salt to 50 gallons). Temperature, 35.5° C. (96° F.). Carbonic-acid gas, 0.5 per cent (4 disks to 2 packages). Duration, eight minutes. Intermission on the fourth day.

*Fourth week* (No. 4 bath): One and a quarter per cent warm salt bath (5 pounds bathing salt to 50 gallons). Nauheim concentrated brine salts. Mutterlauge salts, 8 ounces, or $\frac{1}{2}$ pint of the liquid salts, $CO_2$, 0.75 per cent (6 disks to 3 packages). Temperature, 35° C. (95° F.). Duration, ten minutes. Intermission on the fourth day.

*Fifth week* (No. 5 bath): One a half per cent warm salt bath (7 pounds bathing salt to 50 gallons). Mutterlauge salts, $\frac{3}{4}$ pint, $CO_2$, 0.75 per cent (6 disks to 3 packages). Temperature, 34.4° C. (94° F.).

*Sixth week* (No. 6 bath): Two per cent warm salt bath (10 pounds of bathing salt to 50 gallons). Mutterlauge, 1 pint, $CO_2$, 1 per cent (8 disks to 4 packages). Temperature, 34° C. (93° F.). Duration, fourteen minutes. Intermission on the fifth day.

In the case of robust people we may commence with No. 2 bath, or in the case of delicate persons it may be best not to exceed the strength of No. 4 bath.

The technic of the bath as given in the Hospital of the University of Pennsylvania is as follows:

*Temperature.*—At the beginning of the course have the temperature 33.3° C. (92° F.) to 33.8° C. (93° F.). At the end of the course, 31.1° C (88° F.) to 30° C. (86° F.).

*Duration.*—At the beginning six to seven minutes. At the end, twelve to fifteen minutes.

*Strength.*—The two or three baths at the beginning are given with brine, a mixture of Mutterlauge and common salt, without carbon dioxide. The latter is added at the third or fourth bath. Small amounts are added first and considerably more later. Mutterlauge, imported from German salt works, is added in the proportion of 1 quart to 1 pint of common salt at the beginning of the course. The Mutterlauge is gradually raised to 2 quarts and a common salt remains the same as treatment progresses.

*Frequency.*—At the beginning three times a week with gradually shortened intervals until the baths are taken daily. Twenty-six constitute a course. In Germany an after-cure follows.

**Nauheim Baths.**—It is not the province of this section to treat of balneotherapy as taken at Nauheim, but the following may help in giving the artificial bath.

In preparing the bath the best way is to draw about 20 gallons of hot water in the tub. A tub 5 feet long will then be filled to a depth of 6 inches. The sodium chloride is then dissolved and well distributed, and if the Mutterlauge is to be used it is thoroughly diffused through the bath. The cakes of acid sulphate are now broken with a hammer and laid on the accompanying lead foil and the bicarbonate is laid on top, 2 disks to 1 package. The water is now drawn in the bath so that 50 gallons shall have a temperature as designated, 36.7° C. (98° F.) for No. 1 bath, or 34° C. (93° F.) for No. 6 bath. The alkaline and acid salts are then lowered on their leaden foils at places along the bottom of the tub. Effervescence begins at once, and may take eight or ten minutes for completion. It is best to start with water a little above the required temperature, to allow for cooling; the lead and any undissolved sulphate should be removed before the patient enters.

Massage is not employed in the bath, but afterward the patient is carefully dried with warm towels and put to bed; or, at least, the patient should rest for an hour.

The effect of the baths at Nauheim and of the artificial bath is principally on the heart and bloodvessels. The resistance movements which were systematized by the late Theodore Schott and his brother are an essential feature of the treatment, and are most thoroughly carried out at Nauheim, and are supplemented by the "Terrain Kur," or graduated walks on the hillside (Oertel system).

**The Physiological Effects of the Genuine and Artificial Nauheim Baths.**—The immediate effect of the first bath is a diminished pulse-rate, intensified heart sounds and, in a case of extreme cardiac dilatation, a reduction of the size of the heart and of its cavities. This has been noted by competent observers after a single bath. While the latter is not always maintained, each succeeding bath leaves the organ a little smaller than in the previous one, and thus compensation is finally restored, in most cases at least.

An important point in the selection of cases suitable for Nauheim treatment is that cases in which the neurosal element predominates are more likely to derive benefit than those presenting manifest organic heart changes. Cases of the latter type ought not to be encouraged to go to Nauheim, in the opinion of many competent observers. In many of these cases positive harm results, and the more energetic and prolonged the treatment, the greater the harm. The question arises whether many of the cases reported by Bezly Thorne and other warm advocates of Nauheim treatment are not merely cases of cardiac dilatation, and perhaps hypertrophy, largely due to functional disability of the cardiac ganglia and nerves; the

cardiac bruits, more or less intense and prolonged, usually soft in character, may be wholly of nervous origin, and quite independent of recognizable blood changes in the locality and size of the heart.

## MUD BATHS. PEAT BATHS. FANGO PACKS.

Mud and peat baths have been used for thousands of years in Europe, and they were highly prized by the Romans. At Acqui, in northern Italy, not far from Genoa and Milan, there are hot sulphur springs which were mentioned by Pliny. The baths consist in the application of hot fango, a mud-like substance impregnated into organic matter and with the salts, after mineral waters. The temperature of the mud then applied is about 50° C. (122° F.) or considerably above that, usually employed in mineral baths. This mud is of volcanic origin and is used at Abano, Battaglia and Valdiere in Italy, in Dax and Saint Amand in France. At Buxton, England, there are peat baths; these latter contain both organic and inorganic matter and are applied like immense poultices. Both mud and peat baths are continued much longer than the usual full baths. They may last for an hour or an hour and a half, when applied only locally. They are specially useful in neuralgia, gout, rheumatism, arthritis, lumbago. The fango of Battaglia is a soft grayish-brown plastic substance about the consistency of butter, without odor. It is first applied at about 43.3° C. (110° F.) for ten minutes; in subsequent applications the temperature is graded until 51.7° C. (125° F.) and a duration of twenty, thirty or forty minutes are reached. A more moderate temperature is required where the entire body is enveloped. This mud has been exported from Italy to England and America for this purpose.

*Mud and peat baths* offer several advantages over the ordinary hot baths. The mud is a poorer conductor of heat than is water, and on this account it may be applied to the skin much hotter and much colder than water, without discomfort to the patient. Mud also retains heat longer than does water. The chief advantage, however, lies in the fact that mud is made up of innumerable small, irregular and gritty substances which, on contact with the skin, set up marked irritation, greatly enhancing its action.

## FANGO BATHS.

These baths are applied for rheumatism, gout, arthritis deformans and neuralgias.[14]

They act principally through the heat applied, and are, of course, not dependent on absorption of the mineral contained in the bath. No doubt the skin is favorably affected by the saline and alkaline substances employed. The patient lies in a tub containing the prepared mud mixed with the saline or carbonated water.

*Fango* is an Italian volcanic mud; it is soft, gray-brown, plastic substance, of about the consistency of butter and equally soft to the touch. It has no odor, and after application is quickly and completely removed by a warm douche, leaving the skin absolutely clean. The analysis shows that it is composed of 11 per cent of combustible and volatile matter, with carbonates and sulphates and sulphides of iron and lime and sulphates of potassium and sodium. It is said to be radio-active. The fango is applied warm, like a great sterilized poultice. It conveys heat and retains it. The packs, or fanghi, may be applied first at 43° C. (110° F.) for ten minutes, the temperature and duration increased in successive applications up to 52° C. (125° F.) for twenty, thirty and forty minutes. Massage may be applied gently after the pack.

The fanghi of Salsomaggiore consist of dried potters' clay saturated with the natural saline mineral water and mixed with a considerable quantity of the raw petroleum at one establishment, known as the "Terme Magnaghi," and with the acqua madre, or heavy calcium chloride water at another establishment. The fanghi are kept on for about twenty minutes, are then scraped off and the patient goes to the mineral bath.

Applied in this manner to a joint or a limb the effects are: Stimulation of cutaneous reflexes, with dilatation of superficial capillaries; increased activity in the normal processes of absorption of morbid deposits and repair of damaged tissues. Perspiration is promoted, and there is a slight increase of body temperature, of about 2°, subsiding rapidly after removal of the pack, and due to direct conveyance of heat to the blood.

Dr. Cecil Sharpe, of London, has reported 13 cases of stiff and painful joints treated in this manner. In subacute rheumatism, lumbago, rheumatoid arthritis, neuritis, sciatica, sprains and old injuries of the ankles, fango gives good results. Peat baths are used in chronic pelvic affections. Their action is like that of a widespread poultice. They are useful in gout, rheumatism, lumbago and sciatica.

## SITZ BATH. HIP BATH.

A special tub is required for hip baths, so that the patient may sit in water with her thighs resting against the front of the tub, and her knees, legs and feet protected by a blanket, untouched by the water which rises as high as the umbilicus. The bath may be given cold, hot and graduated.

A cold sitz bath is stimulating to the pelvic and abdominal organs; a hot bath is sedative.

**Cold.**—The bath should be preceded by exercise and is taken in the afternoon unless there are special therapeutic reasons for taking it at some other time. The water must be from 10° C. (50° F.) to 24° C. (75° F.), and the duration of the bath should be from ten to

thirty minutes. The patient should be quickly dried afterward and allowed to rest for half an hour before dressing.

**Hot.**—The bath should not be preceded by exercise and is usually taken at bedtime. The water must be from 40° C. (104° F.) to 45.6° C. (114° F.), and the duration of the bath should be from twenty to thirty minutes. The patient is then quickly dried and placed in bed.

**Graduated.**—The bath should not be preceded by exercise and is taken, as a rule, at bedtime. The temperature of the water in the beginning must be 37.8° C. (100° F.), and the patient then gradually adds water at 10° C. (50° F.) until she begins to feel chilly, which is usually in about ten or fifteen minutes, when she is quickly dried and placed in bed. The top of the patient's head is covered with a cold wet cloth, and the tub is partly filled with water, so that as she sits

FIG. 9.—The sitz or seat bath and liver-spray bath.

down the tub is nearly filled. In this way one is sure that the temperature of the water is right to start with, and it can be raised or lowered afterward if required. If necessary to raise the temperature above 40° C. (104° F.), pitchers of hot water can be added cautiously, or, on the other hand, if necessary to lower the temperature, cold water can be added. In the latter case quick friction of the submerged portions is required. The hot bath raises the pulse and lowers the pressure, the reverse being the case when cold water is used. The results are largely due to reflex excitation of the sympathetic nervous system. The hot bath diverts blood from the abdominal organs, while cold baths congest them. Hence, in all atonic states of the bowels and urinary and generative organs, cold acts as a stimulant if the baths are short and friction is applied. If such baths are prolonged, the stimulant effect is not obtained. It should

be remembered in giving the sitz bath to carefully cover the unimmersed parts of the body, otherwise, the effect may be entirely annulled, especially in intestinal affections.

In menstrual disorders warm and hot sitz baths are often corrective.

Brief cold hip baths are useful in vesical and intestinal paralysis and in debilitative states of the male sexual organs, in prolapsus and in intestinal atony. They are counterindicated in hyperemic states of congestion of the pelvic organs, in sexual or vesical irritability, seminal emissions, tenesmus and menorrhagia.

Prolonged cold hip baths are advocated in hemorrhagic states of the urethra, bladder, intestines and uterus; in hemorrhoids and perimetritis. They are unsuitable in uterine colic, acute cystitis and intense tenesmus.

## HOT MOIST PACK.

This is an old but neglected method. It is applicable when metabolism is defective and it aids elimination through the skin. The very young, the aged and weakly and anemic furnish suitable subjects. Dr. Leonard Williams, of London, advocates it strongly in the sequelæ of scarlet fever, the convulsions of children and in slight catarrhs of the air passages. The hot moist pack is useful in uremia. Many a case of puerperal convulsions has been saved by this procedure. It is commonly used after the warm douche and warm or hot baths in the treatment of gout, rheumatism, syphilis and obesity.

## COLD WET PACK.

**Requisites.**—The bed or table has been prepared; 1 or 2 additional blankets, a linen or cotton sheet, 4 small towels and a hot-water bag. The bag is half filled with hot water, not over 48.9° C. (120° F.). A foot bath is required with water at 38.9° to 40.6° C. (102° to 105° F.). A pitcher of ice-water, a bucket of water for the sheet at 18.3° or 21.1° C. (65° to 70° F.) or at the required temperature.

**Technic.**—The patient in wrapper sits in a convenient chair, with feet in the bath of warm water and with a cold compress on the head. The attendant then wrings out the sheet from the water in the bucket and spreads it smoothly over the bed so as to reach near the foot. The patient then quickly drops all clothing and lies on the wet sheet with the arms extended. The attendant, standing on the right side, promptly draws the overhanging left side of the sheet across the body, smoothing it between the lower limbs and along the right side. The arms are then lowered to the sides and the remaining free portion of the sheet is drawn over the body and smoothly adjusted over the lower limbs, covering in both arms. The feet are left uncovered by the sheet, but the hot-water bag, covered with a towel, is placed at the soles. The underlying blanket is adjusted in a manner similar to the sheet, except that it is not tucked between the lower limbs and the surplus is folded under them. The blanket should be closely

adjusted at the neck *so as to exclude all air*. Another blanket, folded in several thicknesses, is then placed over the entire body from the neck down and tucked snugly in at the sides. A fresh turban of ice-water is adjusted, to be changed every five minutes, as it warms.

It is found in many cases that if the wet sheet is allowed to extend beyond the feet, and is then placed over the feet without the use of hot-water bag, the reaction in the feet is slow and correspondingly unsatisfactory. There is no advantage in covering the feet with the cold wet sheet, and the use of the hot-water bag favors the action of the pack.

## COMPRESSES.

The materials used are linen for the cold wet compress, which is then covered closely by several thicknesses of flannel to prevent outward radiation. For the moist hot compresses well-soaked flannel is used, covered, as in the former case, with a sufficient layer of dry flannel. The good effects of a cold compress are well seen in the treatment of pneumonia. The water should be at 13° to 15.6° C. (55° to 60° F.). The linen compress, 18 inches wide, partly wrung out, is laid smoothly over the affected side, extending slightly beyond the median line front and back, and is then covered with a flannel binder, not too snugly applied. This should be changed night and day every hour, and it is possible to do this without much disturbance of the patient. The danger in these cases is from the intoxication; as a general thing, the intoxication is not so great in pneumonia as in typhoid, and full baths are not desirable. There is a failure in peripheral circulation, and this causes hypertension of the heart, the blood being driven to the inner parts. Just here is where the compress gives timely assistance. The cold stimulates the heart and, with the systole blood, is driven into the peripheral vessels. The central nervous system is also invigorated by the effect of cold on the arterioles. As the skin reacts and the peripheral circulation improves, the heart beats slower and stronger and the increased force and tension of the pulse are shown in the kidney, and we get more urine. The pulse is improved in rate and in character. The crisis is hastened and is marked by a drop in the temperature and a notable reduction in the rate of the pulse. In cases of collapse with cardiac weakness, a cold compress should be placed around the trunk (Neptune's girdle) while the extremities of the limb should be heated.

*The use of ice in pneumonia* rests upon the same basis. The end sought is not the reduction of temperature, but a check to the intoxication by improved circulation and consequent nutrition. It is possible that by these means antitoxins are developed to counteract the infection. The crisis in pneumonia is sudden and not fully to be explained. The remarkable effects cannot be accounted for by immediate changes in the physical condition of the lung. If so, hydrotherapy would be powerless; it is, therefore, a mistake to expect

the compress to cure the condition of the lung itself. If the patient recover he recovers in spite of the pulmonary consolidation; if he dies, it is not altogether from the encroachment on his breathing capacities, but from the intoxication. Put two intoxicants together, as that of alcohol and pneumonia, and the result is usually fatal. As a rule, it is not best to give alcohol in cases of pneumonia treated with compresses, but in alcoholic cases some may properly be given; but it requires nice judgment to decide when to give and when to withhold. As in any other form of treatment, little can be expected from these measures in alcoholic cases, especially if treatment is started late, as, for instance, on the third day.

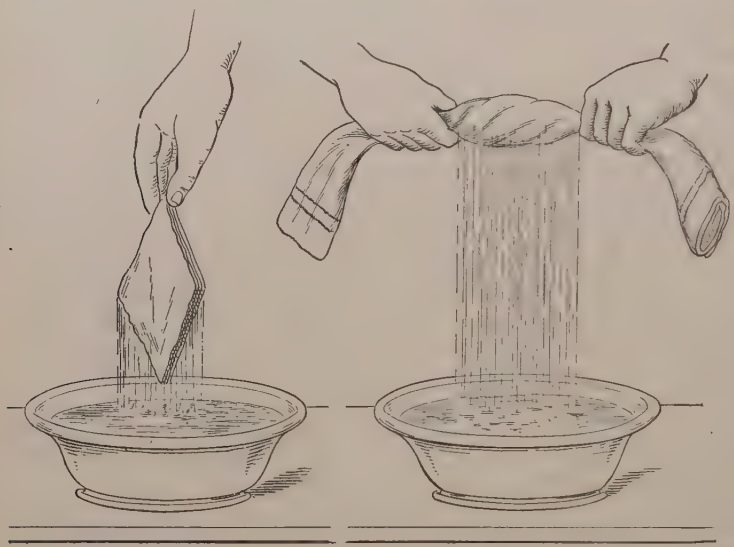

FIG. 10.—Method of wringing out a hot compress without scalding the hands. (From Ashton: The Practice of Gynecology, Philadelphia, W. B. Saunders Company.)

**Ice Compresses.**—The application of ice to the body is best made by means of water-tight rubber ice-bags. It is obviously best to prevent wetting the bed and the patient's clothing. As stated above, we do not aim to reduce inflammation, as in pneumonia, for the lungs of a living man would not be appreciably affected by cold applied outside the chest wall.

**Hot Compresses.**—Dry heat may be applied to the body by means of hot flannel compresses. It is better not to interpose linen or cotton, but to have the flannel in direct contact with the skin. This induces hyperemia of the skin, and relieves internal congestion. The compress should be covered with several folds of flannel to prevent external radiation.

*Moist heat is easily applied by steam compresses.* They are called for in many surgical conditions; they favor suppuration, promote the

absorption of exudates, relieve pain and increase the mobility of stiffened joints. In all cases of rheumatoid arthritis, arthritis deformans with pain and swelling, in sprains, bruises, cramps of the extremities, in biliary, renal and hepatic colic, moist or wet hot compresses are exceedingly useful. Fomentations are useful in sciatic neuritis, multiple neuritis or any non-traumatic neuritis of an advanced stage.

Fig. 10 shows a convenient method of preparing a steam compress. Several layers of flannel of a suitable size and fastened together are dipped into boiling hot water. The area to be treated is then covered with a thin layer of dry flannel—the so-called "baby" flannel answers the purpose best. The wet compress is now dropped into a towel, which is then twisted tightly so as to leave it comparatively dry. It is then unfolded, placed over the dry flannel referred to, and the whole enveloped in a dry flannel binder. Dry and moist compresses require frequent change to be effective, and if applied directly to the skin, should be tested by the physician or nurse before applying to the patient.

In explanation of the relief of pain by means of local heat, it is reasonable to suppose that when arterial and venous congestion occur in a given part there is a corresponding compression of the nerve trunks by the overfilled bloodvessels. Spasm of the nutrient vessels, by which the nerve filaments are compressed, has also been supposed to account for the pain.

In cases of traumatic neuritis a cold compress or an ice poultice, ice and bran mixed, may be placed over the nerve at the seat of injury, while the distal portion of the limb is wrapped in moist, warm flannels.

*Cold applications* are useful in conjunctivitis neonatorum. In the early stages, when the lids are tense and there is little secretion, small square compresses of patent lint (perfect absorbent lint) are laid on a block of ice and are frequently applied to the eyes to keep up a uniform cold impression. They are also useful in the first stage only of traumatic iritis and wounds of the eyeball.

*Fomentations* are used in conjunctivitis neonatorum, especially when corneal complications exist or the conjunctiva has a gray film. These are applied with square of antiseptic gauze wrung out of carbolized water at 49° C. (120° F.), and should be frequently changed. These are used in connection with irrigation of the eyelids.

Fomentations are useful in cases of acute endocarditis having a weak heart and a feeble, irregular pulse. They should be employed locally over the heart, and are more stimulating than ice-bags or cold compresses.

## HOT AND COLD TO THE SPINE.

Fomentations to the spine may be applied alternately with cold sponging. This process is commonly referred to as "hot and cold to the spine." It was used by the late Dr. S. Weir Mitchell and other

neurologists in the treatment of hysteria, neurasthenia and the irritable spine.

The method used varies in different hands. The simplest is the alternate application of two sponges, one dipped in hot and the other in cold water. Or three fomentations may be made, each followed by a sponging with ice-cold water. Each fomentation remains in place three minutes; each sponging consumes fifteen seconds.

## SALT RUB.

**Requirements.**—A tub of salt water at 40° to 40.5° C. (104° to 105° F.) and a box containing finely ground salt. Aston's English salt is suitable. A small handful of the salt is dampened in salt water or other convenient water, and the patient is rubbed more or less vigorously by the attendant. After a thorough rubbing the patient is washed off with a rose spray carrying warm water, which is gradually cooled to the desired temperature. A bath in the full tub may follow this, or may take the place of the spray, and the patient should then be well rubbed with cocoanut oil for fifteen minutes.

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# PART IV.

# MINERAL WATERS OF THE UNITED STATES AND AMERICAN SPAS.

## CHAPTER XIV.

## MINERAL WATERS OF THE UNITED STATES.

### ALABAMA.

Alabama extends from 30°12′ north latitude and from 84°55′ to 88°35′ west longitude, comprising an area of 52,250 square miles, and is in the same latitude as Palestine, northern Africa, Central China and southern Japan. The climate is mild, equable and in the southern portion almost semitropical. The uplands are bracing and healthful, but in the low-lying districts malarial types of fevers are common. The northern portion of the state is considerably colder than the southern, which is accounted for more by the greater elevation than from its higher latitude. The Alleghany Range of mountains reaches into the northern section of the state, but the elevation is not great. The mean annual temperature, as observed at Auburn, near the geographical center of the state, is 16.5° C. (62.37° F.). The mean annual temperature in the valley of the Tennessee River is 15.6° C. (60° F.), and in the extreme southern section of the state the temperature is 20.1° C. (69° F.).

Alabama has 82 spring localities, with a total of 220 springs; only a few of the springs have been analyzed. Peale's list gives 20 localities used as resorts, Walton describes 3 and Bell mentions 3, while Crook describes 5 resort localities. The following list is largely made up from data obtained from Mr. E. A. Smith, state geologist, and from personal investigation, supplemented by correspondence with state and national geological surveys, and with spring owners. It is probable that this list fairly represents the active spring and resorts in use at the present time. Chalybeate and sulphuretted waters are most common and are not confined to any one portion of the state. Sulphur springs predominate in the northern section of the state, where the rocky foundation belongs to the class known as subcarboniferous limestones. Artesian wells are quite common in the region underlaid by the rotten limestone of the Cretaceous period.

## Alabama White Sulphur Springs.

*(DeKalb County.)*

*Postoffice*, Sulphur Springs. *Location*, in northeastern Alabama, west of Ellijay, Ga., 70 miles; southwest of Chattanooga, Tenn., 30 miles; north of Montgomery, the capital city, 175 miles. *Situation*, in the beautiful Willis Valley, lying among the foothills of the outlying spurs of the southwestern extremity of the Blue Ridge Mountains, at an elevation of about 1500 feet above tide water, and surrounded by a picturesque mountainous region of wooded hills and fertile vales. *Access*, via the A. G. S. & N. E. Railway, a connection of the Southern Railway System. *Hotel*, there are ample hotel accommodations. There are five springs in this area. The rocks surrounding the springs are the cherty limestone of the subcarboniferous age, but the underlying Devonian shale is undoubtedly the source of the sulphur water. This black shale is rich in iron pyrites and its decomposition produces sulphur. The analysis below shows the mineralization.

ALABAMA WHITE SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 Analyst, Robert S. Hodges. White Sulphur. | Freestone Spring. |
|---|---|---|
| Lithium chloride (LiCl) | trace | 0.0 |
| Potassium chloride (KCl) | 5.4 | trace |
| Sodium chloride (NaCl) | 3.3 | 2.3 |
| Sodium sulphate ($Na_2SO_4$) | 44.4 | 2.7 |
| Magnesium sulphate ($MgSO_4$) | 276.4 | 10.4 |
| Calcium sulphate ($CaSO_4$) | 75.7 | 0.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 0.0 | 21.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 389.2 | 301.7 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.2 | 1.7 |
| Aluminum oxide ($Al_2O_3$) | 1.3 | 2.1 |
| Silica ($SiO_2$) | 25.8 | 11.0 |
| Total solids | 823.7 | 353.5 |
| Gases: | | |
| Sulphuretted hydrogen, parts per 1,000,000 | 8.1 | 0.0 |
| Carbon dioxide, parts per 1,000,000 | 0.0 | 9.8 |

Medicinal classification, weak alkaline b, weak sulphated, or (−Ab−S). Sulphuretted.

*Chemical Classification.*—The White Sulphur Spring is a moderately mineralized calcic, bicarbonated and magnesic sulphated alkaline-saline water, sulphuretted, possessing diuretic properties. It is said to be useful in gastric dyspepsia and disorders of the alimentary tract, where a slight stimulating laxative is indicated. Likewise, it is said to be useful in some of the milder types of skin disorders.

The Freestone Spring is a lightly mineralized, calcic, bicarbonated,

alkaline water, possessing diuretic and antacid properties, and is said to be of value in the treatment of gastric disorders due to acidity and hyperacidity.

## Bailey Springs.

(*Lauderdale County.*)

*Postoffice*, Bailey Springs. *Location*, in northwestern Alabama, northwest of Montgomery, the capital city, 180 miles; north of Sheffield, 10 miles. *Situation*, in the beautiful valley of Shoal Creek at an altitude of about 900 feet above sea level, surrounded by a wooded forest of indigenous growth. The celebrated Muscle Shoals is only 6 miles away, where the great Wilson Dam was constructed during the World War. *Access*, via the Southern Railway to Florence, thence 10 miles by motor to the Springs, and via the Louisville & Nashville Railway to Florence, thence 9 miles to the springs. *Hotel*, the hotel offers fair living accommodation, and occupies a summit 300 feet higher than Shoals Creek, and has been a popular resort for seventy-five years or more. There are a number of springs in the area of which we present the analyses of the following:

BAILEY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert S. Hodges, Alabama Geological Survey). | | | | | |
|---|---|---|---|---|---|---|
| | Rock Spring. | Free-stone Spring. | Alum Spring. | Chaly-beate Spring. | Soda Spring. | Cave Spring. |
| Sodium chloride (NaCl) | 10.2 | 15.4 | 12.0 | 8.5 | 8.5 | 3.4 |
| Magnesium chloride ($MgCl_2$) | 5.1 | 6.8 | 6.8 | 8.5 | 5.1 | 6.8 |
| Magnesium sulphate ($MgSO_4$) | trace | trace | trace | trace | trace | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 6.8 | 12.0 | 34.2 | 12.0 | 22.2 | 17.1 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 77.0 | 35.9 | 37.6 | 80.4 | 12.0 | 60.0 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | trace | trace | trace | trace | trace | trace |
| Total solids | 99.1 | 70.1 | 90.6 | 109.4 | 47.8 | 87.3 |

This group of springs are so similar in their predominating chemical constituents and amount of total solids that they may be classed as lightly mineralized, calcic, magnesic bicarbonated, alkaline-saline water, possessing slight diuretic and antacid properties. These waters are claimed to be useful in the treatment of gastric disturbances due to acidity and in irritable conditions of the renal and vesical apparatus. The waters are also claimed to be valuable in the treatment of scrofula, leucorrhea and amenorrhea, dysmenorrhea and dropsical conditions.

## Bladon Springs.

(*Choctaw County.*)

*Postoffice*, Bladon Springs. *Location*, in southwestern Alabama, southwest of Montgomery, the capital city, 120 miles; south of Butler, the county seat, 25 miles. *Situation*, in the valley of the Tombigbee River, at an elevation of 170 feet above sea level. The flora and fauna are semitropical and the climate is mild and delightful. *Access*, via the Southern Railway System and connections and via steamers from Mobile, thence 4 miles from steamer landing, at Demopolis, to the springs. *Hotel* and *cottages* furnish excellent accommodations; every comfort and convenience; open throughout the year. There are 4 springs in this area, issuing from the Hatchotigbee clay formations, peculiar to this region. The analysis below shows the mineralization.

BLADON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert S. Hodges). | |
|---|---|---|
| | Vichy Spring. | Sulphur Spring. |
| Sodium chloride ($NaCl$) | 82.1 | 82.1 |
| Sodium sulphate ($Na_2SO_4$) | 0.0 | 6.8 |
| Sodium bicarbonate ($NaHCO_3$) | 1403.6 | 905.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 80.4 | 160.9 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.8 | 1.7 |
| Total solids | 1566.9 | 1157.1 |
| Gases: | | |
| Hydrogen sulphide, parts per 1,000,000 | .. | 5.0 |

The Vichy Spring, medicinal classification, weak alkaline a4 or (−Aa4). This is a moderately highly mineralized, sodic, calcic bicarbonated, alkaline water, possessing diuretic and antacid properties.

The Sulphur Spring, medicinal classification, weak alkaline a3, sulphuretted, or (−Aa3). This is a moderately mineralized, sodic, calcic bicarbonated, alkaline (ferruginous) water, sulphuretted, possessing diuretic and antacid properties. These two springs are interesting from their high content of sodium bicarbonate. These waters are useful in the treatment of gastric conditions due to acidity.

## Blount Springs.

(*Blount County.*)

*Postoffice*, Blount Springs. *Location*, north of the central portion of Alabama; north of Montgomery, the capital city, 110 miles; north of Birmingham, 30 miles. *Situation*, at the foothills of the outlying spurs of the southern extremity of the Blue Ridge Range of mountains; in the Sequatchee Valley, at an elevation of 1580 feet above

sea level, surrounded by a rolling hilly region of wooded hills and pleasing vales. *Access,* via Louisville & Nashville Railway, main line; thence only a short distance to the springs. *Hotel,* the hotel offers fair accommodations and bathing facilities. There are 7 springs in this area, of which we give the analysis of the 3 most important:

BLOUNT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert S. Hodges). | | |
|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. |
| Lithium chloride (LiCl) | 7.2 | * | * |
| Potassium chloride (KCl) | 25.1 | 26.2 | 22.5 |
| Sodium chloride (NaCl) | 516.5 | 507.6 | 472.9 |
| Potassium iodide (KI) | trace | trace | trace |
| Potassium bromide (KBr) | 2.7 | * | * |
| Sodium sulphate ($Na_2SO_4$) | trace | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | 114.1 | 118.6 | 113.5 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 146.3 | 150.0 | 139.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 207.5 | 215.6 | 205.1 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 8.5 | * | * |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 5.6 | * | * |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.5 | 3.2 | 2.5 |
| Aluminum oxide ($Al_2O_3$) | 1.5 | 1.5 | 1.3 |
| Silica ($SiO_2$) | 26.5 | 19.7 | 16.6 |
| Total solids | 1064.0 | 1036.4 | 974.1 |
| Gases: | | | |
| Sulphuretted hydrogen, parts per 1,000,000 | 56.5 | 54.2 | 53.1 |

* Present, but not determined.

Blount Springs No. 1, 2 and 3, medicinal classification, weak alkaline ab, weak saline or (Aab−Cl) sulphuretted. The percentage of the predominating chemical constituents of these springs are so similar that they may all be classed as moderately mineralized, sodic, muriated and sodic, magnesic and calcic, bicarbonated, alkaline-saline water, sulphuretted, possessing diuretic, antacid, tonic and alterative properties. They contain more sulphuretted hydrogen and lithium than any other waters in the state, and in addition they carry in solution appreciable amounts of iodine, bromide, barium and strontium, increasing the alterative action of the waters. These waters have received the approval and endorsement of the medical profession for more than three-quarters of a century. The waters have been used with success in disorders of the digestive apparatus, especially in indigestion due to acidity and hyperacidity; likewise it is a valuable water in certain phases of rheumatism and rheumatic arthritis.

## Cook's Springs.

(*St. Clair County.*)

*Postoffice,* Cook's Springs. *Location,* northeast of central Alabama; north of Montgomery, the capital city, 85 miles; west of Atlanta, Ga.,

110 miles. *Situation*, among the foothills of the western slope of the southern extremity of the Blue Ridge range of mountains, at an elevation of about 1450 feet above tide water, and near the Coosa coal fields. *Access*, via main line of the Southern Railway; through trains to Atlanta and Washington, D. C. *Hotels*, there is a resort hostelry with fair accommodations. There are a number of spring in this area, 4 of which have been analyzed as follows:

COOK'S SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert Hodges). | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Potassium chloride (KCl) | 4.9 | 2.8 | 7.0 | 1.8 |
| Sodium chloride (NaCl) | 4.8 | 6.5 | 0.2 | 4.5 |
| Sodium sulphate ($Na_2SO_4$) | 7.8 | 11.6 | 3.0 | 3.0 |
| Sodium bicarbonate ($NaHCO_3$) | 94.2 | 2.1 | 36.4 | 1.9 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 24.7 | 7.8 | 15.6 | 6.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 91.6 | 40.5 | 47.4 | 11.3 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.8 | 4.0 | 10.8 | 0.8 |
| Silica ($SiO_2$) | 43.8 | 19.5 | 44.8 | 10.8 |
| Total solids | 274.6 | 94.8 | 165.2 | 40.5 |
| Gases: | | | | |
| Sulphuretted hydrogen, cc. per liter | 4.0 | | | |
| Carbon dioxide, cc. per liter | ... | 2.0 | 4.5 | 0.8ā |

No. 1, Sulphur Spring, medicinal classification, sulphuretted. This is a lightly mineralized, sodic, calcic and magnesic, bicarbonated, alkaline water, sulphuretted.

No. 2, Magnesic Spring is a mineralized, calcic, bicarbonated and sodic sulphated alkaline-saline water.

No. 3, Chalybeate Spring is a lightly mineralized, sodic and calcic, bicarbonated, alkaline water.

No. 4, Lithia Spring is a slightly mineralized, calcic, bicarbonated, alkaline water.

The percentage of the predominating chemical constituents in Springs Nos. 1 and 3 are quite similar and their therapeutic properties and uses are likewise similar. These waters ought to be useful in the treatment of digestive disturbances due to acidity and hyperacidity. They also possess tonic properties and should be useful where a mild iron tonic is indicated, such as in anemia and chlorosis, etc.

The Chalybeate Spring, No. 2, contains a fairly good content of the oxide of iron and aluminum and would be indicated where an iron tonic is needed in anemic conditions associated with neurasthenia,

etc. The so-called "lithia" spring is a very slightly mineralized, potable water. This is a very pure water and should have considerable popularity.

### Cullom Springs.

*(Choctaw County.)*

*Postoffice,* Bladen (Bladen Springs). *Location,* in southwestern Alabama; southwest of Montgomery, the capital city, 122 miles; south of Butler, the county seat, 25 miles. *Situation,* in the valley of the Tombigbee River, at an elevation of about 175 feet above sea level. *Access,* via the Southern Railway System connections, thence a short distance by motor to the springs, and via steamers from Mobile to the steamer landing at Demopolis on the Tombigbee River. *Hotel,* there is a resort hostelry with fair conveniences and appointments for the comfort of guests. The springs (wells), 2 in number, were started in 1884 and finished in 1885, reaching a depth of 1345 feet. The surface rocks pierced are the upper strata of the Hatchetigbee formation. The analyses shows the mineralization. There is another "salt well" in the area with a total solids of 10,744.3 parts per 1,000,000.

CULLOM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert S. Hodges). | |
|---|---|---|
| | Sulphur Spring. | Vichy Spring. |
| Sodium chloride ($NaCl$) | 183.1 | 23.9 |
| Sodium sulphate ($Na_2SO_4$) | 13.6 | 29.1 |
| Sodium bicarbonate ($NaHCO_3$) | 1224.0 | 386.9 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 20.5 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 66.7 | 80.4 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.7 | 3.4 |
| Total solids | 1509.6 | 523.7 |
| Gases: | | |
| Hydrogen sulphide, parts per 1,000,000 | 1.7 | |

The Sulphur Spring, medicinal classification, weak alkaline a3 or (−Aa3). This is a moderately highly mineralized, sodic, muriated and bicarbonated, alkaline-saline water, sulphuretted, possessing diuretic, antacid and tonic properties, and should be useful in the treatment of gastric disturbances due to acidity and general acidosis.

The Vichy Springs, medicinal classification, weak alkaline a3 or (Aa). This is a moderately mineralized, sodic, muriated and bicarbonated alkaline-saline water, possessing similar therapeutic properties to the Sulphur Spring.

### Healing Springs.

*(Washington County.)*

*Postoffice,* Healing Springs. *Location,* in southwestern Alabama; north of Mobile, 70 miles; southwest of Montgomery, the capital city,

125 miles. *Situation*, on the banks of Santa Bogue Creek, in a rolling region of country broken by high ridges and forest-covered slopes. The soil is sandy and the section well drained. The elevation is about 400 feet above tide water. The climate is mild and equable. *Access*, via the Mobile & Ohio Railway, thence a distance of 10 miles to the springs. *Hotel*, there is a comfortable resort hostelry, besides numerous cottages. There are some 17 springs in this area. The following have been analyzed, showing the following mineralization:

HEALING SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert S. Hodges). | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Potassium chloride (KCl) | 3.0 | 2.8 | 3.6 | 3.6 |
| Sodium chloride (NaCl) | 3.3 | 3.5 | 2.9 | 2.9 |
| Sodium sulphate ($Na_2SO_4$) | 2.7 | 3.7 | 6.9 | 3.6 |
| Magnesium sulphate ($MgSO_4$) | 9.4 | 7.9 | 6.8 | 6.9 |
| Calcium sulphate ($CaSO_4$) | 3.4 | ... | ... | 2.4 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 2.3 | 4.0 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 30.7 | 37.0 | 33.7 | 18.1 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 4.9 | 4.9 | 5.5 | 4.1 |
| Silica ($SiO_2$) | 28.8 | 27.1 | 29.1 | 26.6 |
| Total solids | 88.6 | 91.2 | 92.5 | 68.4 |
| Flow in gallons per day | 18,700 | 12,000 | 8,000 | 10,000 |

The percentage of the predominating constituents vary so little that they may all be classed as very lightly mineralized, calcic bicarbonated, alkaline-saline water, possessing diuretic, antacid and slight tonic properties. The waters are said to be efficacious in the treatment of many varieties of skin diseases, chronic renal disorders and in the disorders of the bladder and kidneys, and in diseases of the alimentary tract and in hepatic diseases.

These springs were first discovered in 1870, and at one time obtained considerable prominence as a health resort. The waters are under slight hydrostatic pressure, which causes it to rise a few feet above the ground. The water is remarkably clear, pleasant to the taste and acceptable to the stomach. The waters are charged slightly with natural carbon dioxide, which gives the water a sparkle of purity and wholesomeness.

## Livingston Mineral Well.

(*Sumter County.*)

*Postoffice*, Livingston. *Location*, in the extreme western portion of the state; west of the capital city, Montgomery, 110 miles; north of

Mobile, 140 miles. *Situation*, on a sandy plateau, with perfect underdrainage; the well, 1407 feet deep, is situated at the extreme southern out-cropping of the cretaceous limestone, which forms the base of rich prairie belt running through the middle section of the state; it pierces the entire depth of the limestone stratum, reaching the underlying sandstone formation, from which the water is procured. *Access*, via main line of the Alabama & Georgia Railway (eight trains daily), thence a short distance to the springs. *Hotels*, a new modern brick structure, steam heat and electric lights. No bathing establishment, but hot salt baths are given in the hotel. The water on analysis shows the following mineralization:

LIVINGSTON MINERAL WELL.

| Hypothetical combinations. | Parts per 1,000,000 (analyst unknown). |
|---|---|
| Potassium chloride (KCl) | 5,5575 |
| Calcium chloride (CaCl) | 51.0093 |
| Sodium chloride (NaCl) | 5052.0000 |
| Magnesium chloride ($MgCl_2$) | 32.3703 |
| Sodium bromide (NaBr) | 16.7580 |
| Strontium bromide ($SrBr_2$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 39.6720 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 122.0940 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.4884 |
| Ferric perchloride ($Fe_2Cl_6$) | 3.2490 |
| Silica ($SiO_2$) | 19.7598 |
| Total solids | 5365.9583 |

Free carbonic acid, large quantities.

Medicinal classification, saline 3 or (Cl 3), carbon-dioxated. This is a moderately highly mineralized, sodic, calcic, muriated, saline, bromic, carbon-dioxated, water, possessing aperient, tonic and diuretic properties, flowing at the rate of 1 gallon per minute. Local physicians highly endorse the water as beneficial in the treatment of chlorosis, malarial anemia and affections of the bladder and kidneys. The water is very high in sodium chloride and, due to this chemical, it is of value in the treatment of catarrhal conditions of the gastro-intestinal tract and in inflammatory conditions of the biliary tract.

The Alabama Inn, an all-year-round resort, has been open to guests for the past forty years. The cuisine is real southern, of pleasing variety, wholesome, pleasing and appetizing. The water is beautifully clear and limpid when first drawn, effervescing quite actively due to the free carbonic dioxide in solution. The water is bottled and shipped all over the adjoining states.

## Matchless Mineral Wells.

(*Butler County.*)

*Postoffice*, Greeneville. *Location*, some 70 miles south of the center of the state; south of the capital city, Montgomery, about 44 miles;

northeast of Mobile, 130 miles. *Situation*, in a gently rolling region of southern Alabama, at an elevation of 500 feet above sea level. This well was dug about the middle of the nineteenth century, and since then its therapeutic virtues have been known to the profession. *Access*, via main line of the Louisville & Nashville Railway to Greeneville, thence by motor 3 miles to the well. *Hotel*, there are no accommodations for guests. The analysis of the water shows the following mineralization:

MATCHLESS MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, A. L. Metz, M.D.). |
|---|---|
| Sodium chloride ($NaCl$) | 86.9193 |
| Sodium sulphate ($Na_2SO_4$) | 132.0975 |
| Magnesium sulphate ($MgSO_4$) | 1,378.5336 |
| Calcium sulphate ($CaSO_4$) | 1,265.6223 |
| Aluminum and potassic sulphate ($(Al_2SO_4)_3$, $K_2SO_4$) | 425.7905 |
| Ferric sulphate ($Fe_2SO_4)_3$ | 3,655.5525 |
| Ferrous sulphate ($Fe_2[SO_4])_3$ | 14,300.5590 |
| Sodium phosphate ($Na_2HPO_4$) | a trace |
| Silica ($SiO_2$) | 103.4379 |
| Total solids | 21,348.5100 |

Medicinal classification, strong acid ferruginous 2, sulphated or (+AcFe2S). The flow from the two wells is about 1000 gallons each per day. The analysis of both are quite similar in their predominating chemical constituents, and the above analysis shows a highly mineralized, ferruginous, sulphated, acid water, possessing alterative, tonic and astringent properties. It is highly endorsed by the profession of Greeneville and vicinity as a valuable remedy in the treatment of some forms of digestive disturbances, diarrhea, dysentery, colitis, anemia and general debility; locally it has been used with some success in indolent ulcers, hemorrhoids and as a gargle in throat affections. The water is bottled and sold extensively throughout southern Alabama and adjoining states. It has borne an excellent reputation for the past thirty-five years.

## St. Clair Sulphur Springs.

### (*St. Clair County.*)

*Postoffice*, St. Clair Springs. *Location*, in northeastern Alabama; northeast of Birmingham, 40 miles; west of Atlanta, Ga., 105 miles; east of Caldwell, the county seat, 8 miles. *Situation*, among the foothills of the outlying spurs of the southern extremity of the Blue Ridge Mountains, at an elevation of about 1500 feet above tide water, surrounded by a picturesque region of high hills, thickly wooded. *Access*, via the Southern Railway connections, thence only a short distance by motor to the springs. *Hotel*, there are hotel accommodations with fair conveniences for the comfort of guests. There are 6 springs in this

area: (1) Black Sulphur, (2) Sulphur, (3) Freestone and the 3 following, as shown by analysis below. The waters issue from limestone formations overlying thin bedded calcareous shales of the "Flatwoods."

ST. CLAIR SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert S. Hodges). | | |
|---|---|---|---|
| | Spring No. 4. | Spring No. 5. | Spring No. 6. |
| Lithium chloride (LiCl) | trace | Sl. trace | trace |
| Potassium chloride (KCl) | 2.2 | 3.4 | 1.1 |
| Sodium chloride (NaCl) | 6.3 | 16.3 | 5.8 |
| Sodium sulphate ($Na_2SO_4$) | ... | ... | 2.5 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | 3.8 |
| Sodium bicarbonate ($NaHCO_3$) | 21.3 | 69.2 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 98.7 | 89.1 | 99.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 148.7 | 128.6 | 151.6 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | trace | trace | |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace | trace | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.2 | 2.2 | 1.3 |
| Silica ($SiO_2$) | 13.3 | 16.9 | 18.4 |
| Total solids | 292.3 | 319.4 | 283.8 |
| Gases: | | | |
| Sulphuretted hydrogen, parts per 1,000,000 | 0.3 | 8.2 | |

No. 4, White Sulphur Spring is a lightly mineralized, calcic, magnesic and sodic, bicarbonated, alkaline water, sulphuretted.

No. 5, Red Sulphur Spring is a lightly mineralized, calcic, magnesic and sodic, bicarbonated, alkaline water, sulphuretted.

No. 6, Lithia Spring is a lightly mineralized calcic and magnesic, bicarbonated, alkaline water.

The 2 sulphur springs possess antacid and diuretic properties and have been used with success in the treatment of gastric disorders due to acidity and in rheumatic troubles, where an alkaline water was indicated. Good results are also reported from its use in the milder forms of chronic skin disorders.

## Talladega Springs.

(*Talladega County.*)

*Postoffice*, Talladega Springs. *Location*, slightly northeast of central Alabama; north of Montgomery, the capital city, 55 miles; southeast of Birmingham, 32 miles. *Situation*, in the valley of the Coasa River, in the outlying hills of the Blue Ridge Mountains at an altitude of about 1500 feet above sea level. The forest-covered hills are largely of yellow pine and sturdy oaks, while the valleys are fertile and given largely to agriculture. *Access*, via the Louisville & Nashville Railway, on the main line, thence only a short distance by motor to the springs. *Hotel*, there is a resort hostelry with fair accommodations. The springs issue from limestone formations at the foot of the mountains,

Inasmuch as the mountains are mostly in contact with a younger strata on the north by reason of faulting, it is probable that the springs have their origin in the Devonian or lower carboniferous, black shales, both of which appear in the near vicinity, though the rocks from which the water issues seems to be of the Pelman limestone. The analysis below shows the mineralization.

TALLADEGA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert S. Hodges). |
|---|---|
| Lithium chloride (LiCl) | 3.3 |
| Potassium chloride (KCl) | 21.8 |
| Sodium chloride (NaCl) | 357.1 |
| Sodium sulphate ($Na_2SO_4$) | 83.8 |
| Magnesium sulphate ($MgSO_4$) | 89.1 |
| Calcium sulphate ($CaSO_4$) | 26.7 |
| Sodium thiosulphate ($Na_2S_2O_3$) | 1.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 289.2 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 8.4 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.7 |
| Aluminum oxide ($Al_2O_3$) | 0.3 |
| Silica ($SiO_2$) | 13.3 |
| Total solids | 896.0 |
| Gases: | |
| Sulphuretted hydrogen, parts per 1,000,000 | 20.9 |

Medical classification, weak saline (−Cl, −T2) sulphuretted. The analysis shows this to be a moderately mineralized, sodic, muriated and calcic bicarbonated, alkaline-saline, (strontic) water, sulphuretted, and possessing diuretic, laxative, tonic and alterative properties. This water should be useful in the treatment of gastric disturbances due to acidity and hyperactidity. The sulphate radicles present should exert laxative action on the bowel and stimulate hepatic function. The administration of the water should be useful in the treatment of irritation of the renal and vesical organs, and the sulphur present should make the water of value in the treatment of a variety of skin affections.

*Chandler Springs, P. O.*, Chandler Springs, Talladega County. A popular resort as early as 1838. No satisfactory analysis available, and so far as known the property has been allowed to pass into decline; correspondence ignored.

*Coffee Springs, P. O.*, Coffee Springs, Geneva County. Before the Civil War, 1861 to 1865, these springs enjoyed a popular patronage from the citizens of central Alabama, but they have lost their old-time prominence, and have been allowed to decline.

*Howard Springs, P. O.*, Florence, Lauderdale County. There are 3 springs in this area; no hotel; no satisfactory analysis available. The postmaster writes that parties unknown.

*White Sulphur Springs, P. O.*, Jacksonville, Calhoun County. There is said to be a sulphur spring here but no information available and no

analysis. Postmaster marks letters "unknown" and returns correspondence.

There are quite a number of undeveloped springs in the state, some of which contain valuable mineralization.

The following springs reported the commercial sale of waters in 1924.

*Shocco Springs P. O.*, Talladega, Talladega County.

*White Sulphur Springs, P. O.*, Jackson, Clarke County.

## ARKANSAS.

Arkansas extends from 33° to 36°30′ north latitude and from 80°32′ to 94°38′ west longitude. It is nearly square in form, each side measuring about 250 miles, and covers an area of 53,850 square miles, of which 850 square miles are water. The climate is mild, the mean annual temperature in the northern part being about 14.4° C. (58° F.), in the central section 15.7° C. (61° F.) and in the southern about 18° C. (65° F.). The northwestern part is the coldest and the southeastern the warmest. Arkansas has 108 spring localities, with a total of 459 individual springs, but only a very few have been analyzed. The famous Hot Springs are the most favorably known of any of the Arkansas springs. Of the springs whose general character is known probably more than one-half are chalybeate, and the majority of the remaining are sulphuretted. Although many of the springs have been improved, very few have been subjected to quantitative analysis. The following list is made up from geological reports and from correspondence with spring owners. I am under obligations to George C. Branner, state geologist, for much helpful assistance. The list is not complete but fairly representative of the springs in active use at the present day.

The eastern part of the state bordering on the Mississippi is low and swampy, and is annually overflowed. To the westward the country gradually attains a higher elevation, passing into the hills and undulating prairies which lead up to the Ozark Mountains, beyond which an elevated plain stretches toward the Rocky Mountains.

### Arkansas Lithia Springs.

(*Hempstead County.*)

*Postoffice,* Hope. *Location,* in southwest Arkansas; southwest of Little Rock, the capital city, 110 miles. *Situation,* in a picturesque rolling region about 800 feet above sea level. *Access,* via Hope on the Iron Mountain Railway System, thence a distance of 4 miles to the springs. *Hotel,* the accommodations are primitive. There are 2 springs, the water of which have attracted considerable attention beyond the immediate vicinity.

ARKANSAS LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. C. Branner). |
|---|---|
| Potassium chloride (KCl) | 69.12 |
| Sodium chloride (NaCl) | 220.13 |
| Magnesium chloride ($MgCl_2$) | 7.18 |
| Magnesium iodide ($MgI_2$) | 28.40 |
| Magnesium sulphate ($MgSO_4$) | 183.76 |
| Calcium sulphate ($CaSO_4$) | 199.49 |
| Strontium sulphate ($SrSO_4$) | 23.78 |
| Magnesium borate ($MgB_4O_7$) | 1.36 |
| Lithium bicarbonate ($Li[HCO_3]$) | 117.21 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 46.20 |
| Silica ($SiO_2$) | 57.66 |
| Total solids | 953.29 |

Medicinal classification, weak calcic sulphated, very weak ferruginous or (−CaS− −Fe) (iodic). The analysis shows this to be a moderately mineralized, calcic, magnesic, sulphated, sodic, potassic, muriated, lithic, bicarbonated, alkaline-saline (iodic strontic) water, possessing diuretic, tonic and alterative properties. Physicians in the surrounding country have long prescribed this water successfully in the treatment of irritations of the renal and vesical apparatus, stone in the kidney and bladder, disturbances of the digestive organs and in hepatic disorders; it is also a valuable tonic in run-down, debilitated conditions, anemia, chlorosis and in all depraved conditions of the blood and blood-making organs.

## Dove Park Springs.

(*Hot Springs County.*)

*Postoffice,* Dove Park. *Location,* southwest of central Arkansas; southwest of Little Rock, the capital city, 55 miles; southeast of the celebrated Hot Springs, 25 miles. *Situation,* in the valley of White Oak Creek at the base of a sand-covered gravelly hill about 50 feet high, which extends in an east and west direction on the south side of the Creek. The altitude is 295 feet above sea level and surrounded by a rolling hilly region. *Access,* via Witherspoon Station on the Iron Mountain Railway System, thence a distance of 4 miles by motor to the Spring. *Hotel,* there is a typical resort hostelry. There are some 12 springs in the area, of which we give the analyses of 4 showing the following mineralization on page 215.

These springs are situated on low ground on the banks of White Oak Creek and, owing to the boggy nature of the surroundings, it is difficult to determine just how many springs are in this area. A considerable deposit of iron is formed around all of the springs, shown by the brownish deposits from oxidation of the iron content of the waters. The waters all have a pleasant taste and are without odor. They are pleasing to the palate and acceptable to the stomach.

DOVE PARK SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. C. Branner). | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Sodium chloride (NaCl) | 23.44 | 14.23 | 17.72 | 15.23 |
| Sodium sulphate ($Na_2SO_4$) | 32.68 | 16.42 | 21.21 | 31.48 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 16.35 | 21.90 | 14.72 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 79.93 | 54.82 | 54.55 | 24.67 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 20.41 | 19.11 | 24.38 | 20.51 |
| Aluminum oxide ($Al_2O_3$) | 3.42 | 3.76 | 4.45 | 2.05 |
| Silica ($SiO_2$) | 55.77 | 65.59 | 61.76 | 61.42 |
| Total solids | 181.30 | 130.33 | 196.98 | 155.36 |
| Temperature, ° C. | 16.1 | 17.6 | 17.6 | 17.4 |

The analyses shows Spring No. 1 to be a lightly mineralized, calcic, ferruginous, bicarbonated, sodic, muriated, sulphated, alkaline-saline water, possessing antacid, diuretic and tonic properties. Spring No. 2 is a lightly mineralized, calcic, ferric, bicarbonated, alkaline-saline water. Spring No. 3 is a lightly mineralized, calcic, ferric, bicarbonated, alkaline-saline water, possessing diuretic and tonic properties. Spring No. 4 is a lightly mineralized, calcic, ferric, bicarbonated, alkaline-saline water, possessing similar therapeutic properties to Spring No. 1.

These waters have acquired quite a reputation in the treatment of dropsical conditions due to kidney dysfunction indigestion and hepatic disorders.

## Eureka Springs.

(*Carroll County.*)

*Postoffice*, Eureka Springs. *Location*, in the northwestern corner of the state of Arkansas; east of the Missouri boundary line, 5 miles; northwest of the capital city, Little Rock, 200 miles; east of Claremore, Okla., 110 miles. *Situation*, on the summit of the Ozark Mountains, at an elevation of 1200 feet above sea level, on the head waters of the White River, a picturesque stream wandering through a beautiful scenic country of rugged hills and beautiful valleys. *Access*, via Eureka Springs Depot, on the main line of the Missouri & North Arkansas Railway, thence 1 mile by motor to the springs. *Hotel*, there are a number of good hotels. The bathing establishment is equipped for every form of hydrotherapeutic and balneotherapeutic treatment, steam, hot air, Russian, Turkish baths, etc. There are more than 40 springs in this area, which are held in trust by the city, and the waters are free for all time to the public. The waters are clear and sparkling, very palatable and thirst satisfying. We present

the analysis of the Basin Spring and the Magnetic Spring, which shows the mineralization of these waters. Nearly all of the Eureka Springs are affected to some extent by heavy rainfall, after which for some hours the waters contain sediment; at all other times the waters are noted for their purity and clearness. The sloping hills and a tributary of Leatherwood Creek insure rapid and efficient drainage of the vicinity of the springs.

EUREKA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. Analyst, L. F. Miller. Basin Spring. | Analyst, A. E. Menke. Magnetic Spring. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.4 | trace |
| Potassium chloride (KCl) | 1.9 | 1.50 |
| Sodium chloride (NaCl) | 1.3 | 12.35 |
| Sodium sulphate ($Na_2SO_4$) | 3.4 | |
| Magnesium sulphate ($MgSO_4$) | ... | 5.46 |
| Sodium bicarbonate ($NaHCO_3$) | 3.3 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 8.1 | 69.30 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 75.8 | 97.44 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.4 | 1.20 |
| Silica ($SiO_2$) | 5.3 | 9.90 |
| Total solids | 100.9 | 197.35 |
| Temperature, ° C. | 11.6 | 12.0 |
| Radio-activity, Mache units per liter | 65.8 | |
| Flow, gallons per day | 100,000 | 100,000 |
| Gases: | | |
| $CO_2$ in solution, cc. per liter | 125 | 85 |

Basin Spring, medicinal classification, carbon-dioxated, strong radio-active. The analysis shows the Basin Spring to be a slightly mineralized, calcic, magnesic, bicarbonated, alkaline water, carbon-dioxated and radio-activated, possessing diuretic, antacid and slight tonic properties. The predominating chemical constituents in solution are in the form of the bicarbonate of calcium, magnesium and sodium, comprising about 86 per cent of the whole. This water has been successfully used in a variety of digestive disturbances due to acidity and in diseases of the kidney and bladder.

Magnetic Spring. This is a slightly mineralized, calcic and magnesic, bicarbonated, alkaline water, carbon-dioxated, possessing similar therapeutic properties to the Basin Spring. The predominating chemical constituents are about the same, but in percentage almost double that of the Basin Spring. Its indication are in the same diseased conditions.

Besides the magnificent hotels and luxurious bathing establishments, the "city of healing waters" has many outdoor attractions for the sojourner, golf, boating, fishing, motoring and horseback riding. The

beautiful Lake Lucerne, 1 mile from the springs, one of Nature's masterpieces, an opalescent beauty spot, framed in the heart of the Ozarks, and enhanced by a combination of mountain grandeur and mirrored beauty of crystal sheets, whose placid expanse appeals alike to youth and age, with a fascination that makes both glad for the joys of life. The climate of this favored spot is ideal; Nature seems to have been wonderously kind and conciliatory in the matter of climate and location and altitude of Eureka Springs; the scenery is beautiful, inspiring and diversified, such as to be found in few other spots on the continent; the atmosphere has a tang of ozone from the pine forests—invigorating and delightful; the natural advantages here combine to make the weary and ailing forget their ills and become buoyant of spirit, so necessary for recuperation.

## Heber Springs.

(*Cleburn County.*)

*Postoffice*, Heber Springs. *Location*, north of central Arkansas; north of Little Rock, the capital city, 55 miles. *Situation*, among the foothills of the Boston Range of the Ozark Mountains, at an altitude of 750 feet above sea level, surrounded by a panorama of high hills and mountain peaks; to the east lies the towering range of Sugar Loaf Mountains; at the south and west the Blue Mountains. The climate is delightful and invigorating. *Access*, via the M. & N. A. Railway, four trains daily. *Hotel*, there is a hotel with fair conveniences and accommodations; besides, there are a number of places where good rooming accommodations are available. The bathing establishment is modern in construction and equipment; every convenience available for hot and cold sulphur baths, with separate division for ladies and gentlemen. There are a number of springs in this area. The springs issue from a strata of sandstone and shale, dipping under Round Mountain and sloping gradually to Sulphur Creek. The water comes through clay overlying the sandstone below. The analysis on page 218 shows the mineralization.

The Arsenic Springs is a very lightly mineralized, calcic, sodic, bicarbonated, alkaline-saline water.

The Black Sulphur Spring, medicinal classification, weak alkaline a or (−Aa). This is a moderately mineralized, sodic, calcic, bicarbonated, alkaline water, sulphuretted.

The Chalybeate Spring is a very lightly mineralized, calcic, magnesic, bicarbonated, alkaline-saline water.

The Eye Spring, medicinal classification, weak alkaline a or (−Aa). This is a moderately mineralized, sodic, calcic, bicarbonated, alkaline-saline water.

Red Sulphur Spring, medicinal classification, weak alkaline a or (−Aa). This is a moderately mineralized, sodic, bicarbonated and muriated water, sulphuretted.

HEBER SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. A. Menke). | | | | | |
|---|---|---|---|---|---|---|
| | Arsenic Spring. | Black Sulphur Spring. | Chalybeate Spring. | Eye Spring. | Red Sulphur Spring. | White Sulphur Spring. |
| Sodium chloride (NaCl) | 32.2 | 16.4 | 19.5 | 19.8 | 110.2 | 30.2 |
| Potassium chloride (KCl) | | | | | | |
| Sodium sulphate ($Na_2SO_4$) | 12.0 | 45.9 | 18.1 | 45.6 | 30.6 | 21.4 |
| Magnesium sulphate ($MgSO_4$) | | | | | | |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 2.4 | 1.1 | 0.6 | 1.0 | 1.1 | 1.7 |
| Calcium nitrate ($Ca[NO_3]_2$) | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Sodium bicarbonate ($NaHCO_3$) | 61.2 | 405.8 | 25.4 | 401.4 | 330.3 | 28.2 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 36.0 | 72.3 | 38.9 | 66.2 | 21.0 | 40.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 153.2 | 109.4 | 167.0 | 113.2 | 95.2 | 106.4 |
| Silica ($SiO_2$) | 27.9 | 15.9 | 19.8 | 16.4 | 12.1 | 27.6 |
| Total solids | 324.4 | 680.7 | 280.5 | 663.8 | 504.4 | 345.9 |
| Temperature, °C. | 15.5 | 16.7 | 13.3 | 18.0 | 16.7 | 15.6 |
| Flow in gallons per day | 144 | 480 | 100 | 48 | 1152 | 1440 |

White Sulphur Spring is a lightly mineralized, calcic, bicarbonated, sodic, muriated, alkaline-saline water, sulphuretted.

This is a very valuable group of springs, whose waters have been highly endorsed in a variety of disorders in which this class of waters are indicated. Physicians in the surrounding territory prescribe the waters extensively.

## Hot Springs National Park.

*(Garland County.)*

*Postoffice,* Hot Springs National Park. *Location,* near the center of the state; 55 miles southwest of the capital city, Little Rock; 193 miles west of Memphis, Tenn.; 227 miles north of Shreveport; 403 miles south of St. Louis, Mo. *Situation,* in the "valley of contentment," at the base of Hot Springs Mountain, 600 feet above sea level; through this valley runs a beautiful mountain stream, Mountain Creek. Spurs of the Ozark Range of mountains rise on either side of the lazy rollicking stream and shoot their peaks to the height of 1200 feet elevation. *Access,* via Missouri Pacific & Chicago Railway and the Rock Island and Pacific Railway run branch lines into the springs, through sleeping-car service from Chicago, Kansas City, St. Louis and Memphis provide convenient access from all points. *Hotel,* there are about 40 hotels, besides apartments and furnished rooms, where accommodations may be had at one time for more than 25,000. Some of the hotels offer excellent accommodations. *Bathing establishments,* there are 20 on the reservation, 10 near the springs known as "bath house row;" imposing establishments, representing in their equipment an outlay of more than $2,000,000. No spa in the world has any more

ornate or scientifically equipped baths; 10 other establishments are located in the larger hotels and in some sanataria and which may be reached by guests without leaving the buildings. The supervision of all baths and rates charged is under the direction of an agent of the Department of the Interior.

In 1832 four sections of land aggregating 911 acres, including Hot Springs Mountain (at whose base are grouped the 46 hot springs) North Mountain, West Mountain and Whittington Lake, were set aside by act of Congress and thus became our first national park. The above reservation is under the control of the director of National Parks, who is represented in the administration of the park by a resident superintendent. The Federal Government recognizing the curative virtues of the thermic waters on the reservation, established here the Army and Navy General Hospital, which is one of the best equipped and most modern government-owned hospital in the service; it is administered by the War Department for the benefit of officers and enlisted men of the military and naval service, cadets of the Military and Naval Academies, officers of the revenue cutter service and of the U. S. Public Health Service, and honorably discharged soldiers and sailors of the regular and volunteer army and navy of the United States. Admittance through the Adjutants-General Office.

HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 5. | Spring No. 6. |
| Ammonium chloride ($NH_4Cl$) | 0.896 | 0.178 | 0.2020 | 0.128 | 0.2490 | 0.074 |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 3.150 | 3.770 | 3.1500 | 3.830 | 3.1500 | 3.200 |
| Sodium chloride (NaCl) | 0.680 | 0.970 | 1.4400 | 0.770 | 1.1700 | 1.330 |
| Potassium bromide (KBr) | trace | trace | trace | trace | trace | trace |
| Potassium iodide (KI) | trace | trace | trace | trace | trace | trace |
| Potassium sulphate ($K_2SO_4$) | | | | | | |
| Sodium sulphate ($Na_2SO_4$) | 11.590 | 12.090 | 11.4900 | 12.400 | 11.6200 | 11.410 |
| Magnesium sulphate ($MgSO_4$) | ... | 0.090 | ... | 0.310 | ... | 0.990 |
| Sodium borate ($NaBO_2$) | * | * | * | * | * | * |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | trace | trace | trace | trace | trace |
| Sodium nitrate ($NaNO_3$) | 1.200 | 0.600 | trace | 0.600 | 0.6000 | 1.030 |
| Sodium nitrite ($NaNO_2$) | trace | trace | 0.0011 | 0.002 | 0.0033 | 0.002 |
| Sodium bicarbonate ($NaHCO_3$) | 0.620 | ... | 0.8000 | ... | 0.4400 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 28.960 | 28.600 | 29.3800 | 27.820 | 27.5800 | 28.180 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 180.790 | 180.790 | 187.7900 | 180.670 | 188.6500 | 185.900 |
| Ferric bicarbonate ($Fe[HCO_3]_2$) | 0.760 | 0.760 | ... | 1.110 | 0.8900 | |
| Manganum bicarbonate ($Mn[HCO_3]_2$) | 1.160 | trace | ... | 0.710 | 0.7100 | trace |
| Iron and alumina oxide ($Fe_2O_3$, $Al_2O_3$) | ... | ... | 0.4000 | ... | ... | 0.300 |
| Manganum oxide ($Mn_3O_4$) | ... | ... | 0.3000 | | | |
| Calcium silicate ($CaSiO_3$) | ... | ... | ... | ... | ... | 1.020 |
| Silicate ($SiO_2$) | 45.110 | 44.480 | 44.8900 | 43.550 | 44.3100 | 43.980 |
| Total solids | 280.786 | 272.328 | 279.8831 | 270.900 | 279.3723 | 277.416 |
| Temperature, °C. | 61.9 | 61.7 | 61.3 | 61.4 | 61.9 | 58.3 |
| Gases, 1 cc. per liter at 0° C. and 760 mm. pressure: | | | | | | |
| Nitrogen | 9.16 | 7.97 | 8.57 | 7.85 | 8.24 | 8.10 |
| Oxygen | 1.18 | 3.34 | 2.27 | 3.36 | 2.20 | 3.06 |
| Carbon dioxide, free | 10.84 | 9.15 | 13.08 | 12.52 | 12.52 | 10.84 |
| Carbon dioxide† | 31.14 | 29.48 | 30.58 | 29.46 | 31.14 | 29.46 |
| Flow in gallons, twenty-four hours | 28,800 | 10,800 | 19,938 | 3600 | 17,280 | 32,400 |

* Small amount of sodium borate.
† Set free from bicarbonate on evaporating to dryness.

HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 11. | Spring No. 12. | Spring No. 13. | Spring No. 14. | Spring No. 15. | Spring No. 16. |
| Ammonium chloride ($NH_4Cl$) | 0.2820 | 0.0740 | 0.1280 | 0.143 | 0.1190 | 0.0830 |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 3.1600 | 2.5000 | 3.0500 | 2.990 | 3.0500 | 3.0500 |
| Sodium chloride (NaCl) | 1.6800 | 1.9600 | 1.7000 | 1.390 | 1.6500 | 1.4000 |
| Potassium bromide (KBr) | trace | trace | trace | trace | trace | trace |
| Potassium iodide (KI) | trace | trace | trace | trace | trace | trace |
| Potassium sulphate ($K_2SO_4$) | | | | | | |
| Sodium sulphate ($Na_2SO_4$) | 12.2500 | 8.7600 | 12.3600 | 11.760 | 10.3600 | 11.3500 |
| Magnesium sulphate ($MgSO_4$) | ... | 1.0100 | ... | ... | 1.3000 | |
| Sodium borate ($NaBO_2$) | * | * | * | * | 1.9800 | * |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | 0.2100 | trace | trace | 0.0800 | trace |
| Sodium nitrate ($NaNO_3$) | 0.2500 | 0.2500 | 0.2500 | trace | 0.6000 | 0.3700 |
| Sodium nitrite ($NaNO_2$) | 0.0018 | 0.0012 | 0.0018 | 0.005 | 0.0024 | 0.0015 |
| Sodium bicarbonate ($NaHCO_3$) | 1.7500 | ... | 0.4400 | 2.260 | ... | 1.0200 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 29.9800 | 17.9400 | 29.6800 | 29.140 | 29.1400 | 29.0400 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 177.5500 | 104.3300 | 187.1900 | 186.650 | 189.9500 | 183.9500 |
| Ferric bicarbonate ($Fe[HCO_3]_2$) | 0.3800 | 0.3400 | 0.3500 | | | |
| Manganum bicarbonate ($Mn[HCO_3]_2$) | 0.3500 | trace | 0.3800 | ... | 1.0900 | |
| Iron and alumina oxide ($Fe_2O_3$, $Al_2O_3$) | ... | ... | ... | 0.150 | 0.2700 | 0.1300 |
| Manganum oxide ($Mn_3O_4$) | ... | ... | ... | 0.380 | ... | 0.4000 |
| Calcium silicate ($CaSiO_3$) | ... | ... | ... | 0.350 | ... | 0.2300 |
| Silicate ($SiO_2$) | 47.4400 | 32.5200 | 46.1700 | 44.990 | 45.590 | 43.7600 |
| Total solids | 275.0738 | 170.0952 | 281.6998 | 280.208 | 284.8814 | 274.7845 |
| Temperature, °C. | 58.6 | 36.2 | 56.3 | 62.8 | 63.9 | 60.9 |
| Gases, 1 cc. per liter at 0° C. and 760 mm. pressure: | | | | | | |
| Nitrogen | 8.31 | 9.83 | 7.98 | 7.90 | 8.80 | 8.39 |
| Oxygen | 3.56 | 4.61 | 3.31 | 2.81 | 3.79 | 2.49 |
| Carbon dioxide, free | 1.88 | 10.74 | 3.00 | 15.32 | 6.92 | 5.24 |
| Carbon dioxide† | 30.58 | 17.81 | 29.46 | 30.02 | 30.02 | 28.34 |
| Flow in gallons, twenty-four hours | 51.840 | 51.840 | 51.840 | 8.640 | 201.600 | 18.514 |

* Small amount of sodium borate.
† Set free from bicarbonates on evaporating to dryness.

The curative properties of the Hot Springs were known to the red man many hundreds of years prior to the visit of De Soto and his Spanish explorers, who visited the spot in 1541. It is believed that the first white settlement was established in 1800–1807; at any rate, for more than one hundred years it has enjoyed a world-wide reputation in the treatment of certain diseases. In the early days Hot Springs was conducted exclusively as a summer resort; however, in later years, owing to the large numbers who sought this temperate clime to escape the rigors of winters in the North, the spot has grown to be one of the world's greatest "all-year-round resorts." The government exercises a watchful supervision over the medical activities of the reservation, restricting the physicians to those who are licensed practitioners of the state of Arkansas, who have been examined by a Federal board appointed by the Secretary of the Interior.

The character of the waters at Hot Springs National Park are principally *thermal*, 44 being hot and 12 cold. The source of heat is believed to be great masses of igneous rocks intruded below the earth's surface by volcanic disturbances. Surface waters percolating through the various upper strata finally reach this stratum of heated igneous rock and is converted into vapors by contact with the heated mass;

with the free carbonic acid present the vapors are forced upward through fissures and faults in the strata above, and on the way to the surface meet with veins of cold water which are heated by the vapor varying from 38.9° to 64.4° C. (102° to 147° F.). In 1901 J. K. Haywood, of the Water Laboratory, United States Department of Agriculture, Bureau of Chemistry, examined all the springs on the reservation, and we give herewith the mineral analyses of the more important springs.

Springs Nos. 1 to 6, medicinal classification, thermic. The chemical classification shows a moderately mineralized, thermic, calcic, magnesic bicarbonated, alkaline water.

Springs Nos. 11 to 16, medicinal classification, thermic. The chemical classification shows a lightly mineralized, thermic, calcic, magnesic bicarbonated, alkaline water.

HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 31. | Spring No. 32. | Spring No. 33. | Spring No. 34. | Spring No. 35. | Spring No. 96. |
| Ammonium chloride ($NH_4Cl$) | 0.1250 | 0.0690 | 0.1250 | 0.1330 | 0.0680 | 0.0680 |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 3.1500 | 3.2800 | 3.2000 | 3.2200 | 3.2400 | 3.2000 |
| Sodium chloride (NaCl) | 1.8000 | 1.4700 | 1.4800 | 1.7300 | 1.5000 | 1.7000 |
| Potassium bromide (KBr) | trace | trace | trace | trace | trace | trace |
| Potassium iodide (KI) | trace | trace | trace | trace | trace | trace |
| Potassium sulphate ($K_2SO_4$) | | | | | | |
| Sodium sulphate ($Na_2SO_4$) | 11.8700 | 12.2700 | 12.5500 | 11.9600 | 11.0100 | 11.5000 |
| Magnesium sulphate ($MgSO_4$) | 0.9500 | ... | 0.0600 | ... | 0.0600 | 0.9500 |
| Sodium borate ($NaBO_2$) | * | * | * | * | * | * |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | trace | trace | trace | trace | trace |
| Sodium nitrate ($NaNO_3$) | 0.4700 | 0.4700 | trace | trace | 1.8200 | 1.0700 |
| Sodium nitrite ($NaNO_2$) | 0.0012 | 0.0019 | 0.0019 | 0.0024 | 0.0019 | 0.0010 |
| Sodium bicarbonate ($NaHCO_3$) | ... | 0.9300 | ... | 1.2200 | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 27.2700 | 28.4700 | 28.8400 | 27.4700 | 28.7800 | 28.1800 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 184.0700 | 178.7000 | 186.0800 | 184.6000 | 187.2300 | 185.9000 |
| Ferric bicarbonate ($Fe[HCO_3]_2$) | ... | ... | 0.7000 | | | |
| Manganum bicarbonate ($Mn[HCO_3]_2$) | 0.1800 | ... | 0.4800 | | | |
| Iron and alumina oxide ($Fe_2O_3$, $Al_2O_3$) | 0.2700 | 0.2700 | ... | 0.3400 | 0.2700 | 0.2700 |
| Manganum oxide " ($Mn_3O_4$) | ... | 0.170 | ... | 0.0500 | 0.2800 | 0.1500 |
| Calcium silicate " ($CaSiO_3$) | ... | 1.8300 | ... | 0.2900 | 0.2600 | 1.2300 |
| Silicate ($SiO_2$) | 47.4000 | 47.3200 | 49.6000 | 46.7500 | 46.4400 | 48.2100 |
| Total solids | 278.1862 | 275.2509 | 283.1169 | 278.5654 | 280.9599 | 282.6950 |
| Temperature, °C. | 51.4 | 46.5 | 49.2 | 47.9 | 48.9 | 57/8.9 |
| Gases, 1 cc. per liter at 0° C. and 760 pressure: | | | | | | |
| Nitrogen | 9.98 | 9.10 | 9.84 | 10.34 | 9.97 | 8.61 |
| Oxygen | 2.21 | 3.66 | 2.82 | 2.07 | 2.76 | 3.02 |
| Carbon dioxide (free) | 14.75 | 8.04 | 6.36 | 11.40 | 14.20 | 10.84 |
| Carbon dioxide† | 29.45 | 29.47 | 31.15 | 29.56 | 30.02 | 29.47 |
| Flow in gallons, twenty-four hours | 7200 | 27,200 | 7200 | 28,800 | 2469 | 9600 |

* Small amount of sodium borate.
† Set free from bicarbonates on evaporating to dryness.

Spring Nos. 31 to 36, medicinal classification, thermic. The chemical classification shows a lightly mineralized, thermic, calcic, magnesic bicarbonated, alkaline water. A careful study of the analyses of the various springs reveals a similarity in chemical constituents of the different waters; they may all be classed as thermic, calcic, sodic,

magnesic, bicarbonated, alkaline (ferruginous, bromic waters, carbon-dioxated-azotized).

The physiological action of the hot baths increases the body temperature, stimulates heart action, diminishes blood-pressure and stimulates nutritive changes in the tissue cells, especially those composing the organs of elimination. The waters and baths are used with pleasing results in gout and chronic rheumatic disorders, malarial poisoning, in catarrh of the gall-bladder and ducts, in certain pelvic inflammations in women, in many types of chronic skin disorders, in syphilis and syphilitic complications, in gonorrheal rheumatism, in toxemia and in conditions of defective elimination.

The Hot Springs National Park region offers many advantages for those who crave rest and leisure, with no desire for sports or athletics, because here are many lovely spots where mountainous beauty joins with the quiet of a wilderness, where Nature can be found primitive and primeval and in her most peaceful mood. (See also Chapter XV.)

### Mountain Valley Springs.

*(Garland County.)*

*Postoffice,* Mountain Valley. *Location,* in central Arkansas; southwest of Little Rock, the capital city, 60 miles; north of Hot Springs, the county seat, 12 miles. *Situation,* in a beautiful valley which reaches well up into the mountain range near the foot of Blakely Mountain Range, at an elevation of about 750 feet above sea level. *Access,* via Missouri, Pacific & Rock Island Railway Systems, and via motor from Hot Springs National Park, leading through a beautiful picturesque mountainous region 12 miles to the springs. *Hotel,* accommodations good at the Hot Springs National Park. The analyses shows the mineralization.

MOUNTAIN VALLEY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. C. Branner). |
|---|---|
| Sodium chloride ($NaCl$) | 7.36 |
| Sodium sulphate ($Na_2SO_4$) | 10.95 |
| Potassium sulphate ($K_2SO_4$) | 1.03 |
| Magnesium sulphate ($MgSO_4$) | 12.66 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 7.59 |
| Ferrous sulphate ($FeSO_4$) | 0.34 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 52.66 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 315.43 |
| Silica ($SiO_2$) | 15.57 |
| Total solids | 423.59 |

Medicinal classification, weak alkaline b or (−Ab). The analyses shows this to be a moderately mineralized calcic, magnesic, bicarbonated, alkaline water, possessing diuretic, antacid and slight tonic properties. The waters are used with success for the various affections of the kidneys and bladder, diabetes, etc. The waters are sold

extensively as a table water and as a good potable water for the sick room. Its high degree of purity give it extraordinary keeping qualities. It is pleasing and palatable to the taste.

### Ozarka Springs.

(*Carroll County.*)

*Postoffice*, Eureka Springs. *Location*, in the northwestern corner of the state, within a few miles of the Missouri boundary line; northwest from the capital city, Little Rock, 200 miles. *Situation*, northeast of Eureka Springs 1½ miles, in the most picturesque beautiful section in the entire Ozark region. The springs issue from a fault in the rocky strata, in a beautiful spot 2000 feet elevation above sea level, on the head waters of the White River. The climate is salubrious and delightful. *Access*, via Eureka Springs Station on the Missouri & Northern Arkansas Railway, thence by motor a short distance to the springs. *Hotels*, there are a number of good hostelrys in the town. There are two bathing establishments in the town, both modern in construction and equipment. The great variety in accommodation are such as to fit the purse of all guests, from luxury to bare comforts. There are a great number of springs in the Eureka Springs area. The Ozarka Springs, 2 in number, are valuable waters, and have long been used commercially. The bottling plant is modern in construction and equipment, every precaution being supervised to insure the sanitary handling of a medicinal water.

OZARKA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Kansas City Testing Laboratory). |
|---|---|
| Sodium chloride (NaCl) | none |
| Magnesium chloride ($MgCl_2$) | 6.00 |
| Calcium chloride ($CaCl_2$) | none |
| Magnesium sulphate ($MgSO_4$) | 9.50 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 18.60 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 116.20 |
| Aluminum oxide ($Al_2O_3$) | 0.70 |
| Silica ($SiO_2$) | 7.20 |
| Total solids | 158.20 |
| Flow in gallons per day | 100,000 |

The analysis shows this to be a lightly mineralized, calcic bicarbonated, alkaline water, possessing diuretic and slight antacid properties. This water owes its delightful akalinity to the bicarbonates of calcium and magnesium, which makes it a valuable water in all gastric disturbances due to acidity and hyperacidity; likewise it is of value in the treatment of irritable conditions of the genito-urinary tract. The *U. S. Geological Survey* says: "This is the purest undistilled water in the world. If these springs were examined more closely fewer people would be sent across the ocean to improve their health." Each liter

of the water contains 9.5 cc. of gaseous content, consisting of carbonic acid gas and oxygen, which add to its pleasing taste and therapeutic properties.

### Potash-sulphur Springs.

(*Garland County.*)

*Postoffice*, R.R. No. 2 Hot Springs National Park, Hot Springs. *Location*, in central Arkansas; southwest of Little Rock, the capital city, 50 miles; west of Memphis, Tenn., 225 miles. *Situation*, in a beautiful valley of Onchita River, in the heart of the Ozark Mountains, at an altitude of 1100 feet above sea level, surrounded by beautiful lakes constructed by damming the River at three different points, one Lake Catherine fronting on the Potash-sulphur property, adding much to its already picturesque attractiveness. *Access*, via Lawrence Station on the Rock Island Railway, thence by automobile over the great Malvern National Highway less than 1 mile to the springs. *Hotel*, there is a modern resort hostelry of 52 rooms, single and *en suite*, with up-to-date conveniences for the guests. Bathing facilities, modern, ample and up-to-date. There are 3 valuable springs in this area, of which we present the analyses of 2 of the more important herewith. These springs issue from metamorphosed sedimentary rock, all within an area of 20 square feet. Their potassium and sodium mineralization is no doubt derived from the orteolase in feldspar which holds these minerals in the the same proportion as the potash-sulphur water. It is of interest to note that adjoining the feldspar mineralization there are extensive ore bodies of uranium, the mother ore of radium, which confer to the Potash-sulphur Springs radio-active emanations. The springs are improved with modern spring houses, etc. The waters have attained quite a wide reputation for their valuable therapeutic properties. The analyses shows the mineralization:

POTASH-SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, J. C. Branner.) Spring West. | (Analyst, Lederle Laboratories.) Spring East. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | trace | 5.64 |
| Lithium chloride (LiCl) | ... | trace |
| Potassium chloride (KCl) | ... | trace |
| Sodium chloride (NaCl) | 86.23 | 80.04 |
| Potassium sulphate ($K_2SO_4$) | 561.20 | |
| Sodium sulphate ($Na_2SO_4$) | 15.05 | 314.48 |
| Sodium bicarbonate ($NaHCO_3$) | 289.65 | 515.36 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | trace | 2.92 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 13.59 | 2.39 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 8.86 | |
| Sodium silicate ($Na_2SiO_3$) | ... | 4.79 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | ... | 1.10 |
| Sodium sulphide (NaS) | trace | |
| Silica ($SiO_2$) | 32.50 | 31.41 |
| Total solids | 1087.07 | 960.13 |

West Springs, medicinal classification, weak sulphated or (−S−T3). The analysis shows West Springs to be a moderately mineralized, potassic, sulphated, sodic bicarbonated and muriated, alkaline-saline water, sulphuretted, possessing diuretic, tonic and alterative properties.

East Spring, medicinal classification, weak alkaline a, or (−Aa−T2). The East Spring is a moderately mineralized, sodic, bicarbonated, sulphated, muriated, alkaline water, possessing diuretic, antacid and tonic properties. These waters are very highly endorsed by the profession in a wide range of diseased conditions. They have been found useful in the treatment of disturbances of digestive organs, in constipation and catarrhal disorders of the intestinal tract, in jaundice and hepatic disorders, rheumatism and the uric-acid diathesis, gout and lithemic disturbances, cystitis and renal and vesical calculi.

## Raveden Springs.

(*Randolph County.*)

*Postoffice*, Raveden Springs. *Location*, in northeastern Arkansas; northeast of Little Rock, the capital city, 120 miles; northwest of Memphis, Tenn., 100 miles; 5 miles from Raveden Station. *Situation*, in the foothills of the Ozark Mountains, at an elevation of 1200 feet above sea level, surrounded by a series of high hills, presenting interesting vistas of great picturesque charm and natural beauty. *Access*, via the Frisco Railway System, main line, from Kansas City to Jacksonville, Fla., to Raveden Station, thence 5 miles by motor to the springs. *Hotel*, there is a good hotel with modern convenience. The analyses below shows the mineralization.

RAVEDEN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Wright & Merrill). |
|---|---|
| Sodium chloride (NaCl) | 37.47 |
| Magnesium chloride ($MgCl_2$) | 51.48 |
| Calcium chloride ($CaCl_2$) | 21.21 |
| Calcium sulphate ($Ca_2SO_4$) | trace |
| Lithium bicarbonate ($LiHCO_3$) | 35.92 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 124.18 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 127.78 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 40.37 |
| Silica ($SiO_2$) | 36.02 |
| Total solids | 474.43 |
| Temperature, °C. | 15.6 |
| Gases: | |
| Carbon dioxide on evaporation, cc. per liter | 73.1 |
| Oxygen, cc. per liter | 40.5 |

Medicinal classification, weak mineralization or (−T). The analysis shows this to be a moderately mineralized, calcic, magnesic

lithic bicarbonated, alkaline-saline (ferruginous) water, slightly carbon-dioxated, possessing diuretic antacid and tonic properties. This water has become a popular remedy in the treatment of gastric disturbances, indigestion and dyspepsia, etc.; likewise in irritable conditions of the bladder and kidneys its use is general for the relief of renal and vesical calculi; its solvent action is well known. In rheumatism and the uric-acid diathesis it has become a popular remedy.

*Allen's Alterative Spring, P. O.*, Hot Springs, Garland County. No satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Gillen's White Sulphur Springs, P. O.*, Hot Springs, Garland County. No satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Sulphur Springs, P. O.*, Sulphur Springs, Benton County. No satisfactory analysis available and correspondence unanswered.

The following springs have been used as resorts, but no definite information available, viz:

*Blanco Springs*, Hot Springs County.

*Mount Nibo Springs*, Gill County.

*Searcy Springs*, Crawford County.

The following springs reported the commercial sale of water in 1924:

*Arsenic Spring, P. O.*, Hot Springs, Garland County.

*De Soso Spring, P. O.*, Hot Springs, Garland County.

*Happy Hollow Springs, P. O.*, Hot Springs, Garland County.

*Raleigh Springs, P. O.*, Little Rock, Pulaski County.

*Sulphur Magnesia, P. O.*, Hot Springs, Garland County.

## ARIZONA.

Arizona extends from 109° to 114°47′6.5″ west longitude and from 31°29′24″ to 37° north latitude, and comprises an area of 113.916 square miles, or nearly three times that of the state of New York. The climate is salubrious and pleasant, except in the lower sections of the state where the summers are exceedingly hot. The rainy season occurs during the months of June, July, August and September. The annual rainfall does not exceed 7 inches, and as a consequence there are on an average of 350 sunny days in the year. The excessive dryness of the climate prevents the heat from being oppressive. The temperature, though high, is much less disturbing than that of much lower degrees in other localities.

Peale mentions 26 spring localities with 30 individual springs. Definite information concerning the mineral springs of Arizona is difficult to obtain, and the list given herewith is incomplete. Numerous inquiries have failed to secure definite information of many of the springs. In some portions of this great domain alkaline, saline and

sulphuretted waters are so numerous that they attract but little attention. Saline springs appear to be the most abundant, and a large number of them are thermic, many of which no doubt will eventually be used for bathing purposes. I am under obligations to G. H. Butler, Dean and Director of the College of Mines, for information about the few springs listed herewith.

## Agua Caliente Hot Springs.

(*Maricopa County.*)

*Postoffice*, Agua Caliente. *Location*, in southwestern Arizona; southwest from Phoenix, the capital city, 80 miles; north of the Mexican boundary line, 65 miles. *Situation*, in the picturesque valley of the Gila River, on its way to join the Colorado, at an elevation of about 6000 above sea level, surrounded by a rough and rugged mountainous region. *Access*, via Sentinel Station, on the Southern Pacific, thence by motor, through a wild picturesque mountainous region, 14 miles to the springs. The new branch of the Southern Pacific now under construction will come within $2\frac{1}{2}$ miles of the springs. *Hotel*, the hotel is a commodious resort hostelry, with modern conveniences and accommodations. The cuisine is excellent and the service good. There are 16 springs in this area. The analysis below shows the mineralization of one of the group:

AGUA CALIENTE HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, W. P. Blake). |
|---|---|
| Sodium chloride ($NaCl$) | 320.00 |
| Sodium sulphate ($Na_2SO_4$) | 150.00 |
| Potassium sulphate ($K_2SO_4$) | 15.70 |
| Magnesium sulphate ($MgSO_4$) | 16.20 |
| Calcium sulphate ($CaSO_4$) | 39.50 |
| Sodium bicarbonate ($NaHCO_3$) | 85.96 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 7.45 |
| Sodium silicate ($Na_2SiO_3$) | 80.20 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 3.00 |
| Silica ($SiO_2$) | trace |
| Total solids | 718.01 |
| Temperature, °C. | 52.4 |

Medicinal classification, weak saline, weak total mineralization 2, or $(-Cl-T_3)$ thermic. The analysis shows this to be a moderately mineralized, thermic, sodic, muriated and sulphated, saline water, possessing diuretic and tonic properties. The hot baths in this water as well as the mud baths have been found effective in the treatment of rheumatism, rheumatoid arthritis and chronic joint disturbances and in chronic skin diseases, etc.

## Castle Hot Springs.

*(Yavapia County.)*

*Post Office,* Hot Springs. *Location,* southwest of central Arizona; north of Phoenix, the capital city, 67 miles; east of Wickenburg, 35 miles. *Situation,* on the upper border of the celebrated Salt River Valley, on a branch of the Agua Erian River, a wild, untamed mountain stream rushing furiously along to join the Colorado River. This stream skirts the southern slopes of the Wickenburg Mountains, where this spring gushes forth from the bosom of Mother Nature, at an elevation of about 2100 feet above sea level. The climate of Salt River Valley is semitropical; perhaps the highest temperature recorded in the United States was at Tempe near Phoenix, when where the mercury stood at 46.2° C. (115.5° F.) in the shade. The excessive dryness of the atmosphere prevents the high temperature from being oppressive. It is said that sunstroke is unknown here. The winters in this section are charming and delightful. *Access,* via the Santa Fe Railway and connections to Hot Springs Junction, thence by motor over interesting scenic mountainous highways, through a rough and rugged region to the springs. *Hotel,* there is a modern resort hostelry providing good accommodations. There is a bathing establishment which has been patronized for more than a quarter of a century. Persons suffering from phthisis are not accepted as guests. There is one spring here which according to legend was known of and used by the red men of the forest long before the coming of the white man. Here they brought their sick and wounded and applied the wonderful "medicine water" until health and strength were restored.

CASTLE HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Dept. Agriculture). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | |
| Lithium chloride (LiCl) | trace |
| Sodium chloride (NaCl) | 220.72 |
| Sodium sulphate ($Na_2SO_4$) | 311.40 |
| Sodium nitrate ($NaNO_3$) | |
| Potassium bicarbonate ($KHCO_3$) | 18.82 |
| Sodium bicarbonate ($NaHCO_3$) | 3.42 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 119.77 |
| Ferrous bicarbonate ($Fe[HCC_3]_2$) | 11.98 |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silica ($SiO_2$) | 59.88 |
| Total solids | 745.99 |
| Temperature, °C. | 65.6 |
| Flow in gallons per day | 400,000 |

Medicinal classification, mineralization weak 2, or (−T2) thermic. The analysis shows this to be a moderately mineralized, thermic, sodic,

muriated and sulphated, alkaline-saline water. This water possesses diuretic, antacid and laxative properties and some slight tonic action. The water has been successfully administered for the relief of constipation and in hepatic disorders where stimulation of the liver and bile ducts were necessary.

### Clifton Hot Springs.

(*Grunlee County.*)

*Postoffice*, Clifton. *Location*, in southeastern Arizona; east of Phoenix, the capital city, 165 miles; south of St. Johns, 100 miles. *Situation*, on the Francisco River at the eastern foothills of the Gila Range of mountains, at an elevation of about 3460 feet above sea level. *Access*, via the Southern Pacific Railway System and connections. *Hotel*, no accommodations at spring but good hotels in Clifton. The spring on analysis shows the following mineralization:

CLIFTON HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Smith Emory & Co.). |
|---|---|
| Lithium chloride (LiCl) | 6.0 |
| Potassium chloride (KCl) | 366.0 |
| Sodium chloride (NaCl) | 7561.0 |
| Magnesium chloride ($MgCl_2$) | 86.5 |
| Calcium chloride ($CaCl_2$) | 2216.0 |
| Calcium sulphate ($CaSO_4$) | 89.8 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 162.0 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 6.9 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 3.3 |
| Silica ($SiO_2$) | 64.00 |
| Total acids | 10,551.5 |

Medicinal classification, strong saline or (+Cl). The analysis shows this to be a highly mineralized thermic, sodic, calcic, potassic, muriated saline (manganic) water, possessing diuretic, aperient, tonic and alterative properties. While the spring is undeveloped and unexploited, still great numbers of people come to the spring and drink the water with much benefit in stomach and bowel disorders. Deep holes have been dug in the ground and allowed to fill with the hot water and used as baths for rheumatism and obstinate skin affections.

### Mineral Park Bitter Spring.

(*Mohave County.*)

*Postoffice*, Mineral Park. *Location*, in western Arizona; east of the Nevada boundary line, 25 miles; northwest of Phoenix, the capital city, 165 miles. *Situation*, on the eastern slope of the Cerbat Range

of mountains, at an elevation of about 9000 feet above sea level. *Access*, via Cerbat Station on the Southern Pacific Railway, thence by motor over a macadam mountain highway, through a wild and romantic region clothed with spruce, fir and pine forests, a distance of some 10 or more miles to the springs. *Hotel*, there is a resort hostelry offering ample accommodations. There is one spring whose waters have been analyzed, which shows the following mineralization:

MINERAL PARK BITTER SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Oscar Lowe). |
|---|---|
| Potassium chloride (KCl) | trace |
| Sodium chloride (NaCl) | trace |
| Magnesium chloride ($MgCl_2$) | 54.0 |
| Sodium sulphate ($Na_2SO_4$) | trace |
| Magnesium sulphate ($MgSO_4$) | 653.0 |
| Calcium sulphate ($CaSO_4$) | 1185.0 |
| Ferrous sulphate ($FeSO_4$) | trace |
| Manganous sulphate ($MnSO_4$) | trace |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silica ($SiO_2$) | 20.0 |
| Total solids | 1912.0 |

Medicinal classification, calcium sulphated or (CaS). The analysis shows this to be a moderately highly mineralized, calcic, magnesic, sulphated, saline water, possessing diuretic and slight laxative action. The sulphate radicles are present in sufficient amount to produce stimulation of the bowels and liver, making it a valuable water in the treatment of sluggish bowel action and retarded hepatic function.

## CALIFORNIA.

California extends from 32°34′ north latitude and from 114°8′ to 124°24′ west longitude, and comprises an area of 188,981 square miles, being the second state in size in the union. The state is naturally divided into four distinct regions, viz: (1) the Coast Range, (2) the Sierra Nevada, (3) the Central Valley and (4) the Southwestern. The climate of the state varies considerably in different portions of the vast area. The mean annual temperature of the northern section being below 10° C. (50° F.), while in the southeastern section it exceeds 21.1° C. (70° F.). The mean annual temperature at San Francisco for a period of ten years was 23.3° C. (74.77° F.). The interior of the state, not being influenced by the sea, has a continental climate, and the greater the distance from the ocean the cooler the nights and the warmer the days. California has well been called the "garden of the world," for, embracing as it does every kind of soil and climate, it yields all the products of the temperate and many of the tropical and semitropical regions.

California has 220 spring localities, with a total of 435 individual springs, 44 of which have been analyzed. The California springs embrace all types of mineral waters, the sulphuretted, carbonated,

alkaline, saline, chalybeate and acid predominating. Naturally many of them are thermic, for the volcanic rocks with which such springs are usually associated are found in many portions of the state. A large number of the springs in the state have been improved and used as resorts. The best known probably are the Geyser Springs in Sonoma County, which are a collecton of fumaroles, solfataras and boiling springs. There are nearly a dozen localities where the waters are bottled and shipped.

The list of springs given here has been compiled from various sources geological reports, Dr. Winslow Anderson's work, Peale's report, Crook's work and from correspondence with spring owners. While this list is not complete, it fairly represents the number of springs in active use as resorts and those shipping waters commercially.

### Adams Springs.

(*Lake County.*)

*Postoffice*, Adams Springs. *Location*, in mid-western California; north of San Francisco and Oakland, 93 miles; northwest of the capital city, Sacramento, 70 miles; south of Clear Lake, 8 miles. *Situation*, in the western edge of Cobb's Valley; the springs issue from a fault overlying red sandstone and shales in a deep ravine about 3300 feet above sea level, surrounded by rolling, rugged hills which are thickly shrouded in verdant loveliness for a greater part of the year. The climate is uniformly dry, balmy and salubrious, much like that of Nice, France. *Access*, via the Southern Pacific to Calistoga, thence by auto stage to the springs, a distance of 30 miles, leading through a beautiful mountain country, over splendid roads. *Hotel*, there is a commodious resort hostelry, modern in equipment and conveniences for comfortably entertaining 400 guests. Accommodations are available to suit the individual taste as well as the purse, rooms with and without bath. There is a large out-door swimming pool. The springs were discovered about fifty years ago by a Mr. Adams, and at once became popular.

ADAMS SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, T. Price). |
|---|---|
| Sodium chloride (NaCl) | 70.53 |
| Potassium sulphate ($K_2SO_4$) | trace |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 1580.74 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2745.71 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 795.90 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 14.14 |
| Silica ($SiO_2$) | 123.50 |
| Total solids | 5330.52 |
| Temperature, °C. | 10 |
| Flow in gallons per day | 720 |
| Gases: | |
| Carbon dioxide, free, cc. per liter | 458 |

Medicinal classification, alkaline ab3, or (Aab3), carbon-dioxated. The analysis shows a moderately highly mineralized, magnesic, sodic, bicarbonated, alkaline (ferruginous) water, carbon-dioxated, possessing diuretic, antacid and slight tonic properties. The waters have been used with success in the treatment of digestive disturbances due to acidity and hyperacidity; it has also given relief in rheumatic disorders, and is said to be efficacious in Bright's disease. It is also of value in the treatment of anemia, chlorosis and all depraved conditions of the blood and blood-making organs. The popularity of the waters are appreciated by the large number of people who resort here year after year. The mineral waters and the delightful climatic conditions, the balmy, bracing atmosphere, etc., attract the health-seeker; for pleasure-seeker there are varied attractions, mountain climbing, motoring, swimming, golf and hunting in season. A competent physician is always on hand to advise about the water cure, etc.

### Anderson's Mineral Springs.

(*Lake County.*)

*Postoffice,* Middletown. *Location,* western California; north of San Francisco, 60 miles; west of Sacramento, the capital city, 60 miles; west of Calistoga, 20 miles. *Situation,* in a cozy nook in a small canyon at an elevation of 1625 feet above sea level, surrounded by high hills, heavily wooded, weird canyons and dashing waterfalls. The surroundings here about offer the student of Nature all that can be desired. *Access,* via the Southern Pacific to Calistoga, thence by motor a short distance to the springs. *Hotel,* there are ample hotel accommodations; cottages for those who desire privacy and seclusion. There are a number of springs in the area.

The Cold Sulphur Spring, medicinal classification, weak alkaline 3b, weak sulphated or (−Ab3, −S), carbon-dioxated. This is a moderately highly mineralized, calcic, magnesic sulphated and bicarbonated, alkaline-saline (ferruginous) water, carbon-dioxated and sulphuretted, possessing diuretic and antacid tonic properties.

The Iron Spring, medicinal classification, weak sulphated, very weak mangano-ferruginous or (−S, − −MnFe). This is a moderately mineralized, thermic, sodic, calcic, magnesic, sulphated, alkaline-saline (ferruginous) water, possessing diuretic antacid and tonic properties

The Sour Spring, medicinal classification, very weak acid aluminic 2 or (− −AcAl2). This is a lightly mineralized, aluminic, magnesic, calcic, sulphated acid water, containing free sulphuric acid. The waters possess astringent tonic and gentle laxative properties.

The Belmar Spring, medicinal classification, weak alkaline b, weak sulphate or (−Ab, −S), carbon-dioxated. This is a moderately mineralized, thermic, calcic, sulphated and bicarbonated alkaline-saline water, carbon-dioxated, sulphuretted, possessing diuretic antacid and laxative properties.

ANDERSON'S MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | |
|---|---|---|---|---|---|
| | Analyst, Dr. W. Anderson. | Analyst, Geo. E. Colby. | | Analyst, Dr. W. Anderson. | Analyst, Geo. E. Colby. |
| | Cold Sulphur Spring. | Old Iron Spring. | The Sour Spring. | Balmar Spring. | Hot Spring. |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace |
| Sodium chloride (NaCl) | 18.63 | 3.12 | 1.40 | 10.94 | 7.57 |
| Ammonium sulphate ($[NH_4]_2SO_4$) | ... | ... | 5.57 | | |
| Sodium sulphate ($Na_2SO_4$) | 105.78 | 58.49 | 8.41 | 135.26 | 94.35 |
| Potassium sulphate ($K_2SO_4$) | trace | 19.97 | 14.80 | ... | 23.25 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | 121.61 | | |
| Magnesium sulphate ($MgSO_4$) | 289.84 | 125.83 | 81.49 | 143.64 | 102.77 |
| Ferric sulphate ($Fe_2[SO_4]_3$) | ... | ... | 10.84 | | |
| Calcium sulphate ($CaSO_4$) | 155.61 | 186.11 | 35.86 | 156.80 | 66.82 |
| Sodium arsenate ($Na_3AsO_4$) | ... | ... | ... | ... | trace |
| Calcium phosphate ($Ca_3[PO_4]_2$) | ... | 2.63 | ... | trace | trace |
| Potassium bicarbonate ($KHCO_3$) | trace | ... | ... | trace | |
| Sodium bicarbonate ($NaHCO_3$) | 256.84 | 3.35 | ... | 22.57 | 5.47 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 324.94 | ... | ... | 75.90 | 42.41 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 565.12 | ... | ... | 447.98 | 288.01 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 12.74 | 32.78 | ... | 3.32 | 3.68 |
| Manganous bicarbonate ($Mn[HCO_3]_2$) | ... | 49.08 | ... | ... | 17.61 |
| Aluminum oxide | ... | 1.59 | ... | trace | trace |
| Silica ($SiO_2$) | 41.89 | 72.10 | 67.42 | 71.82 | 112.86 |
| Total acids | 1771.39 | 555.05 | 374.40 | 1068.23 | 766.99 |
| Gases: | | | | | |
| Carbon dioxide, free, cc. per liter | 590 | 6.4 | ... | 513.6 | 242 |
| Hydrogen sulphide, cc. per liter | 14.74 | ... | ... | 32.6 | 12.5 |
| Free sulphur acid ($H_2SO_4$), cc. per liter | ... | ... | 4.2 | | |
| Temperature, °C | 16.7 | 51.1 | 17.8 | 23.3 | 63.3 |

The Hot Spring, medicinal classification, weak total mineralization 2 or (−T2) carbon-dioxated. This is a moderately mineralized, thermic, sodic, magnesic, calcic, sulphated, calcic, bicarbonated, alkaline-saline water, sulphuretted and carbon-dioxated, possessing diuretic and antacid properties.

## Arrowhead Hot Springs.

(*San Bernadino County.*)

*Postoffice,* Arrowhead Springs. *Location,* in the southeastern section of the state; north of San Bernadino, 6 miles; east of Los Angeles, 60 miles; west of Phoenix, Ariz., 300 miles. *Situation,* in the upper section of the "valley of romance," at the foot of Arrowhead Mountain, one of the outcroppings of the San Bernadino Mountains, at an elevation of 2000 feet above sea level. On the southern slope of this

mountain, so named from the sharply-defined outline of an arrowhead, placed on the south side of this mountain by the hand of Nature, lies the celebrated Arrowhead Hot Springs. This gigantic arrowhead, 3500 feet above sea level, covers an area of $7\frac{1}{2}$ acres and measures in length 1370 and in breadth 449 feet, and can be readily seen clearly outlined against the mountain for a distance of 30 miles. The scenery of the wonderful "valley of romance," with its environed everlasting hills, from snow-capped summits to tropical clime, presents a most charmingly picturesque panoramic picture of mural charm and beauty; rugged, awe-inspiring, where the giant hills brood in silent gloom. *Access*, via the Atkinson, Topeka & Santa Fe Railway, the Southern Pacific and Pacific Electric via Los Angeles and via motor over the finest state highways in the world. *Hotel*, this hostelry is built in harmony with its rugged surroundings, mission style of architecture, granite, steel and concrete construction, and offers all the conveniences of the best metropolitan hotel. The bathing establishment, on the second floor of the hotel, segregated by an enclosed arcade from the rest of the house, is one of the most modernly equipped bath houses in the West; provisions are made for giving the latest and most approved service in the science of hydrotherapy and balneotherapy—especially mud baths, mineral-water baths, electric baths, steam baths, vibratory massage, etc. The men's and women's department are under the direct supervision of the medical director, and his skilled assistants, masseurs and masseuses. There are a number of springs, about 20 in all, but we only give the analyses of a few of the more important.

ARROWHEAD HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. E. Bailey, Ph.D.) | | |
|---|---|---|---|
| | Penyugal Hot Springs. | Granite Spring. | Palms Spring. |
| Ammonium chloride ($NH_4Cl$) | 0.150 | 0.110 | 0.135 |
| Lithium chloride (LiCl) | trace | trace | trace |
| Potassium chloride (KCl) | 31.800 | 25.300 | 24.500 |
| Sodium chloride (NaCl) | 97.500 | 102.600 | 89.500 |
| Sodium sulphate ($Na_2SO_4$) | 782.000 | 737.100 | 644.000 |
| Sodium metaborate ($NaBO_2$) | 41.400 | 36.500 | 26.400 |
| Disodium arsenate ($Na_2HAsO_4$) | 0.744 | 0.496 | 0.595 |
| Magnesium sulphate ($MgSO_4$) | 4.400 | 2.000 | 3.900 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | trace | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 112.600 | 104.500 | 116.500 |
| Magano-manganic oxide ($Mn_3O_4$) | trace | trace | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.500 | 0.080 | 2.000 |
| Calcium silicate ($CaSiO_3$) | 9.600 | 1.750 | |
| Silica ($SiO_2$) | 93.000 | 102.350 | 100.500 |
| Total solids | 1174.694 | 1111.886 | 1008.030 |
| Gases at °C. and 760 mm. pressure: | | | |
| Hydrogen sulphide ($H_2S$), cc. per liter | 0.55 | 0.22 | none |
| Free carbon dioxide ($CO_2$), cc. per liter | none | none | none |
| Carbon dioxide ($CO_2$), set free from bicarbonate on evaporation to dryness), cc. per liter | 17.7 | 14.4 | 15.9 |

Penyugal Hot Springs, medicinal classification, weak sulphated 2, weak total 3 or (−S2, −T3), thermic. The flow from Penyugal Hot Spring is 55,000 gallons in twenty-four hours, at a temperature of 94.4° C. (202.2° F.). This is believed to be the hottest water of any curative spring or spa in the world. The water boils vigorously and steam is constantly escaping from the spring, with a perceptible odor of hydrogen sulphide in the escaping vapors. The water has just gas enough and mineral taste to give it snap and make it lively, pleasant and palatable for drinking purposes. It is a moderately mineralized, arsenic, sodic, sulphated saline water, sulphuretted.

Granite Hot Springs and Palm Hot Springs, medicinal classification, weak sulphate 2, total 3 or (−S2, −T3), thermic. These two springs, located near the Penyugal Hot Springs, have a common origin, and by comparing the analyses it will be seen that they are quite similar in their predominating chemical constituents. Disodium arsenate is a very rare ingredient of mineral waters, and besides the Arrowhead Hot Springs there is only one other group of springs in the world that contains this valuable mineral constituent, and that is the celebrated arsenic springs at La Bourboule, France. They are moderately mineralized, sodic, muriated, sulphated, calcic, bicarbonated, alkaline-saline (arsenated) waters, possessing diuretic, antacid, laxative and alterative properties. Disodium arsenate in mineral waters acts as an alterative; it increases the appetite and digestion and improves the whole nutrition of the body, and is of decided value in the treatment of anemia, diseases of the integumentary system and of the ductless and lymphatic glands. These waters are highly extolled as valuable agents in the treatment of disorders of the gastro-intestinal tract, liver and kidney, metabolism and general debility.

ARROWHEAD HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. E. Bailey, Ph.D.) Water from steam caves. | Hot mud deposit from Palm Hot Springs. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.091 | 6.390 |
| Lithium chloride ($LiCl$) | trace | trace |
| Potassium chloride ($KCl$) | 42.000 | 68.300 |
| Sodium chloride ($NaCl$) | 82.900 | 174.500 |
| Sodium sulphate ($Na_2SO_4$) | 688.000 | 1179.000 |
| Sodium metaborate ($NaBO_2$) | 27.700 | 115.000 |
| Disodium arsenate ($Na_2HAsO_4$) | 0.644 | 2.492 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 112.000 | 314.000 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | ... | 517.000 |
| Magnesium sulphate ($MgSO_4$) | 4.900 | 11.300 |
| Mangano-manganic oxide ($Mn_3O_4$) | trace | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.850 | 2.680 |
| Silica ($SiO_2$) | 102.000 | 156.800 |
| Total solids | 1068.385 | 2547.462 |
| Gases at 0° C. and 760 mm. pressure: | | |
| Hydrogen sulphide ($H_2S$), cc. per liter | none | none |
| Free carbon dioxide ($CO_2$) | none | none |
| Carbon dioxide ($CO_2$) set free from bicarbonates on evaporation to dryness, cc. per liter | 15.2 | 111.6 |

The steam caves and mud baths are additional features of the great therapeutic potency of the disodium arsenate in these waters; steam caves and the hot mud which is dipped up from the residue of the hot waters are used medicinally. We present the analyses of both on page 235.

The steam caves are room-like cavities in the conglomerate strata and are filled with natural steam issuing from the rocks, the temperature varying from 70° C. (158° F.) to 93.3° C. (200° F.). It is believed that these caves are the hottest natural steam baths in the world. The red men regarded this place with veneration. Here Nature furnished them with natural steam baths, right on the side of a cool mountain stream; they had all the advantages of a Turkish bath out in the forest primeval. It is claimed that patients may go into the caves, sufferers from lumbago, rheumatism, sciatica, neuritis, and after a few steam baths, come out freed of their ills, and with a feeling of buoyancy and rejuvenation.

## Azule Springs.

(*Santa Clara County.*)

*Postoffice*, Saratoga. *Location*, in the western part of the state; south of San Francisco, 50 miles; west of San Jose, 12 miles; 2 miles from Saratoga. *Situation*, in a ravine across the divide from Congress Springs, at an elevation of 1000 feet above sea level. *Access*, via Saratoga Station on the Southern Pacific Railway, thence by motor a distance of 2 miles to the springs. The mountains to the southwest, when viewed from a distance, present a bluish scenic panorama of great charm and beauty, hence the name "Blue Springs," by which the place was once known. *Hotel*, there is a hotel with some modern conveniences and a number of cottages comprise the accommodations. The springs issue from a fault in a dark-colored sandstone, serpentine in character, and flows pure and sparkling, heavily charged with natural carbon-dioxide gas, from Nature's subterranean laboratory. The following analysis shows the mineralization.

AZULE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. Howden). |
|---|---|
| Sodium chloride (NaCl) | 1983.08 |
| Potassium chloride (KCl) | 186.39 |
| Magnesium chloride ($MgCl_2$) | 297.88 |
| Sodium bicarbonate ($NaHCO_3$) | 1445.83 |
| Potassium bicarbonate ($KHCO_3$) | 67.60 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2116.41 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 278.39 |
| Silica ($SiO_2$) | 55.72 |
| Total solids | 6363.70 |
| Gases: | |
| Carbon dioxide, free, cc. per liter | 2606 |
| Temperature, °C. | 15.6 |
| Flow in gallons per day | 500 |

Medicinal classification, alkaline ab2, saline or (Aab2, Cl), carbon-dioxated. The analysis shows this to be a moderately highly mineralized, magnesic, sodic, bicarbonated, sodic muriated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, aperient and tonic properties. It is highly useful in habitual constipation and digestive disturbances due to acidity and hyperacidity; it is also valuable in the treatment of irritable states of the bladder and kidneys. The large content of magnesium ions is noteworthy; its carbonated pungency is very similar to the celebrated seltzer spring at Nassau, in Germany.

## Bartlett Springs.

(*Lake County.*)

*Postoffice*, Bartlett Springs. *Location*, north of central California; north of San Francisco, 125 miles. *Situation*, in the Coast Range of mountains, near the head of Cache Creek, at an elevation of 2160 feet above sea level. *Access*, via the Northwestern Pacific Railway or the Southern Pacific Railway. *Hotel*, there are a unit of 3 hotels with cottages, which provide ample accommodations. The bathing establishment is modern in construction and equipment. The hot soda and magnesia mineral water baths are highly valued in the treatment of rheumatic and chronic articular joint disturbances. The water on analysis reveals the following mineralization:

BARTLETT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Curtis & Tomkins). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.11 |
| Potassium chloride (KCl) | 0.75 |
| Sodium chloride (NaCl) | 11.00 |
| Sodium sulphate ($Na_2SO_4$) | 27.40 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.80 |
| Sodium metaborate ($NaBO_2$) | trace |
| Disodium arsenate ($Na_2HAsO_4$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 9.10 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1874.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 257.30 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.20 |
| Silica ($SiO_2$) | 54.70 |
| Total solids | 2239.36 |
| Gases: | |
| Carbon dioxide, free, cc. per liter | 283.00 |

Medicinal classification, alkaline b or (Ab), carbon-dioxated. The analysis shows this to be a moderately highly mineralized magnesic, calcic, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic and antacid properties. The waters have long been popular in the treatment of gastric disturbances due to acidity and hyperacidity. It is also useful in the treatment of bladder and kidney affections, gout and rheumatism. Its action slightly stimulates hepatic function,

and increases the flow of all body fluids, gastric juice, pancreatic juice, and promotes appetite and digestion. Outdoor amusements for devotees of golf, horseback-riding, tennis, bowling, dancing and music.

### Brockway Hot Springs.

*(Placer County.)*

*Postoffice*, Brockway. *Location*, on the eastern boundary of the state; west of Carson City, the capital of Nevada, 20 miles; northeast of Sacramento to the capital city of the state, 100 miles. *Situation*, at state-line point, on the upper end of Lake Tahoe, California's great inland sea, 21 miles long and 12 miles in width and at its deepest point 1645 feet. Altitude, 6250 feet above sea level, facing the lake to the south, with Pluto Mountain to the north; altogether, makes an ideal setting for a health resort. *Access*, via Truckee Station on the Southern Pacific, thence a distance of 14 miles, over splendid mountain highways, leading through a picturesque rough and rugged mountain region to the springs. *Hotel*, there is a large commodious hostelry recently constructed and fitted with every convenience for the comfort of guests. The hot sulphur water, tasteless and odorless, is piped to every room. The bathing establishment is modern in construction and equipment, offering every facility for the administration of the latest science of hydrology and the application of the famous hot sulphur baths. Besides the hotel there are 12 private cottages, furnishing additional accommodations; in addition, there is a large casino or club house, where the kitchens and dining rooms are situated. The 900-acre estate with farms and gardens insure a plentiful supply of fresh fruits and vegetables, and the farm dairy an abundance of fresh cream, milk and butter for the table. The water is charged with sulphuretted hydrogen and has a temperature of 58.9° C. (138° F.). Water from another group of springs situated near the edge of the lake, about 150 yards northwestward, is pumped to a nearby tank and used for bathing, culinary and laundry purposes. The analysis below of the former described spring shows the mineralization:

BROCKWAY HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Curtis & Tomkins). |
|---|---|
| Sodium chloride ($NaCl$) | 213.00 |
| Magnesium chloride ($MgCl_2$) | none |
| Sodium sulphate ($Na_2SO_4$) | 79.00 |
| Calcium sulphate ($CaSO_4$) | none |
| Magnesium sulphate ($MgSO_4$) | none |
| Sodium nitrate ($NaNO_2$) | none |
| Sodium bicarbonate ($NaHCO_3$) | 19.44 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 34.02 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 56.70 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.00 |
| Silica ($SiO_2$) | 76.00 |
| Total solids | 480.16 |
| Temperature, °C. | 58.9 |
| Flow in gallons per day | 5000 |

Medicinal classification, weak mineralization, or (−T) thermic. The above analysis shows a moderately mineralized, thermic, sodic, muriated alkaline-saline water, sulphuretted, possessing diuretic, antacid and tonic properties. The sodium, magnesium and calcium bicarbonates will counteract excessive acidity of the stomach, and the sodium sulphate and the sodium chloride will stimulate intestinal secretion, and thereby produce mild laxative action. The waters are used with success in rheumatic disturbances and in digestive disorders due to hyperacidity and in catarrhal diseases of the intestinal tract. The chemical analysis also indicates that the waters would be effective in the treatment of congested conditions of the liver and sluggishness of the gall ducts. The climatic conditions would benefit patients suffering from chronic bronchitis, asthma and incipient phthisis. Besides the splendid hotel and bathing establishment there are many outdoor attractions to claim the attention of those who are devotees of golf, beach bathing, swimming, horseback-riding, fishing, hiking and motoring.

## Busch Medical Springs.

(*Mendico County.*)

*Postoffice,* Potter Valley. *Location,* on the western border of the state; north of Sanoma County, 110 miles; northwest of Sacramento, 150 miles; east of the Pacific Coast, 40 miles. *Situation,* among the foothills of the western slopes of the Coast Range of mountains, surrounded by picturesque panorama of rugged hills and deep vales. *Access,* via the Ukiah or Willets on the Northwestern Pacific Railway, thence by motor from Willets 15 miles and from Ukiah 26 miles, over graded macadam highways and through a picturesque enchanting mountain region of great charm and beauty. *Hotel,* a small hotel with modern conveniences, hot and cold running water, etc. The meals are good and wholesome and the service satisfactory; no bathing establishment.

BUSCH MEDICAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Curtis & Tomkins). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 3.8 |
| Lithium chloride (LiCl) | 2.9 |
| Potassium chloride (KCl) | 42.6 |
| Sodium chloride (NaCl) | 574.0 |
| Potassium iodide (KI) | 0.7 |
| Potassium bromide (KBr) | 0.7 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 1.7 |
| Sodium metaborate ($NaBO_4$) | 748.1 |
| Disodium arsenate ($Na_2HAsO_4$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 3571.2 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2150.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 424.2 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 28.3 |
| Silica ($SiO_2$) | 97.2 |
| Total solids | 7649.6 |
| Gases: | |
| Carbon dioxide, cc. per liter | 603.5 |

Medicinal classification, alkaline ab 3, weak saline or (Aab 3, −Cl), carbon-dioxated. The analysis shows this to be a moderately highly mineralized, sodic, magnesic, bicarbonated, muriated, borated, alkaline-saline (ferruginous) water, carbon-dioxated, possessing diuretic, antacid, tonic and alterative properties. This water should be a valuable adjuvant in the treatment of gastric affections due to acidity, and in all irritable conditions of the genito-urinary tract. It likewise is valuable in the treatment of anemia chlorosis, and in all run-down conditions where an assimilable iron tonic is indicated. The water carries 28.3 mg. of the bicarbonate of iron to the liter, and is one of the valuable chalybeate waters of the state.

## Byron Hot Springs.

(*Contra Costa County.*)

*Postoffice*, Byron Hot Springs. *Location*, in the western portion of the state; northwest of San Francisco, 68 miles; southeast of Mount Dible, 16 miles; northeast of Stockton, 25 miles. *Situation*, near the foothills of the Coast Range of mountains. The springs are tucked away in a cool oasis of living green, 100 feet above sea level, in a little valley, just over the fringe of the hills that mount upward toward Mount Dible. *Access* via Byron Station, on the main line of the Southern Pacific Railway from San Francisco to Stockton, thence by motor 1½ miles to the springs. *Hotel*, there is a large commodious hostelry and a number of handsome cottages for private and family use, altogether furnishing accommodations for 300 guests. The excellence of the cuisine is a feature of the hotel, nourishing and appetizing viands are supplied in abundance and special dietaries when ordered. The bathing establishment is located on the first floor of the hotel and so conveniently arranged that guests can pass from their rooms to a special elevator and through a private arcade, which is heated during the winter, and reach the baths without coming in contact with other guests, and all under the same roof. The equipment of the baths represent the latest science in balneotherapy and hydrotherapy, all of which is under the immediate supervision of an eminent physician trained in the science and art of hydriatics. There is a separate corps of trained masseurs and masseuses for the men's and women's departments. There are some 50 springs in this locality, many of which have been analyzed, but we only give here 4 of the most important, which will show the mineralization.

No. 1, medicinal classification, strong saline (iodic) or (+Cl (I)), thermic. This is highly mineralized, thermic, sodic, calcic, muriated, saline (bromic; iodic) water. The potassium salts and other chemical constituents, principally chlorides, make the water diuretic, detergent and alterative in action. It has been used with success in rheumatism, gout, joint diseases and cutaneous affections.

BYRON HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analysts, Curtis & Tomkins. | | | Analyst, Dr. W. Anderson. |
| | No. 1, Hot Salt Spring. | No. 2, Liver and Kidney Spring. | No. 3. White Sulphur Spring. | No. 4, Black Sulphur Spring. |
| Ammonium chloride ($NH_4Cl$) | 30.438 | 38.133 | 0.362 | trace |
| Lithium chloride (LiCl) | 71.182 | 12.312 | | |
| Potassium chloride (KCl) | 36.423 | 54.378 | 6.327 | 609.102 |
| Sodium chloride (NaCl) | 9581.200 | 10,935.792 | 306.432 | 6754.500 |
| Magnesium chloride ($MgCl_2$) | 462.645 | 508.647 | ... | 17.100 |
| Calcium chloride ($CaCl_2$) | 1812.600 | 1388.691 | ... | 153.900 |
| Potassium bromide (KBr) | 26.505 | 27.189 | 2.763 | 2.736 |
| Potassium iodide (KI) | 21.204 | 21.586 | 2.763 | 12.564 |
| Sodium sulphate ($Na_2SO_4$) | ... | ... | 87.723 | trace |
| Potassium sulphate ($K_2SO_4$) | ... | ... | ... | trace |
| Calcium sulphate ($CaSO_4$) | trace | trace | trace | 54.720 |
| Sodium sulphide ($Na_2S$) | ... | ... | 15.048 | |
| Calcium phosphate ($Ca_3[PO_4]$) | trace | trace | 1.710 | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 360.639 | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 178.182 | 322.335 | 59.337 | 101.745 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | ... | 52.497 | 162.450 |
| Ferrous bicarbonate ($Fe[HCO_3]$) | 8.037 | 10.330 | ... | 11.970 |
| Barium bicarbonate ($Ba[HCO_3]$) | 11.628 | 11.628 | 4.788 | trace |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 2.052 | 2.223 | | |
| Silica ($SiO_2$) | 29.754 | 30.780 | 46.170 | 18.810 |
| Total solids | 12,271.860 | 13,364.024 | 945.559 | 7899.597 |
| Gases, cc. per liter: | | | | |
| Free carbon dioxide | 4.45 | 7.23 | none | none |
| Free hydrogen sulphide | 0.41 | 0.28 | 16.7 | 14.8 |
| Temperature, °C. | 50 | 14.4 | 21.1 | 32.2 |

No. 2, medicinal classification, strong saline (iodic) or (+Cl (I)). This is a highly mineralized, sodic, calcic, muriated, saline (bromic, iodic) water, sulphuretted, with the chlorides predominating, which give this water valuable tonic and alterative properties in hepatic disorders, chronic dyspepsia, etc. It exerts decided diuretic action.

No. 3, medicinal classification, weak alkaline a (iodic) or (−Aa (I), −T 2), sulphuretted. This is a moderately mineralized, sodic, muriated, bicarbonated, saline (bromic) water, sulphuretted. It is a palatable water; its action is tonic, diuretic, alterative, aperient and antacid. It is valuable in the treatment of glandular enlargements, rheumatism, uric acid and joint diseases.

No. 4, medicinal classification, saline 4 (iodic) or (Cl 4 (I)), sulphuretted. This is a moderately highly mineralized, sodic, potassic, muriated and bicarbonated, saline (iodic) water, sulphuretted, possessing diuretic, aperient and alterative properties.

The peat or mud baths given here are practically identical with the famous "moor soil" of Carlsbad; the medicated waters have been bubbling through the peat for centuries; the mud is not brought from a distance, but is at hand constantly warmed by the natural hot waters. The application of this "peat bath" is by immersing the body in a vat with only the head above the surface of the warm peat. The physiological effect produced dilates the bloodvessels of the skin, thus underlying congestion is relieved and a profuse perspiration produces a sensation of delightful rest and comfort while the curative action of the bath takes place. The sanitarium department is under the constant care of a resident physician and a corps of trained nurses, and every care and attention is given patients.

## The California Geysers.

(*Sonoma County.*)

*Postoffice*, Cloverdale. *Location*, in western California; northwest from San Francisco, about 100 miles; west of Sacramento, the capital city, 80 miles. *Situation*, in Geyser Canyon, in Sulphur Creek Valley; in the northeastern corner of Sonoma County, at an elevation of 1700 feet above sea level, surrounded on all sides by mountainous, craggy peaks. To the eastward rise up the St. Rhelean Range of mountains to meet the horizon. This marvelous region has become widely known, both for the scenic grandeur and scientific interest of the region; but it is only proper to state that there are no true geysers, intermittently, throwing out hot water at this place. *Access*, via the Southern Pacific to Calistoga, and thence by motor, over good mountain roads, leading through a picturesque mountainous country robed in evergreen verdure of indigenous flora, gigantic oaks and towering pines, 26 miles to the springs; or via Cloverdale on the same railway, and thence by motor over graded mountain roads, through an equally interesting region, marked by hugh boulders, rocky cliffs, as the road winds through the mountain side and over the Pluton River (this time on a bridge), 16 miles to the springs. *Hotel*, the hotel is commodious and has been in continuous operation for nearly half a century; a few years ago a number of cottages were erected and the bathing establishment overhauled, remodeled and enlarged, so that now the hotel and bathing establishment are equipped with modern conveniences. The main group of springs and vents that constitute the so-called geysers issue on the mountain side just to the north of the canyon, within an area that extends 300 yards along the canyon side and about an equal distance north from Sulphur Creek. In this area are 12 flowing hot springs, 12 vapor vents and a cool iron spring and a cool sulphur drinking spring. About 175 yards eastward from this group, and on the steep slope 50 feet above the stream, is another group from which the largest flowing spring issues; the waters are piped

across the stream into the hotel and bathing establishment. Hot vapor from a large vent is also piped across the stream and supplies the vapor baths. One of the most noted vents in this Plutonian Realm has been christened "Steamboat Geyser," on account of its peculiar weird noise; the steam is said to have originally issued from a small orifice, but a few years ago a practical joker drove a piece of $1\frac{1}{2}$-inch pipe into the opening and attached a steam whistle, the roarings of which so disturbed the guests at the hotel that it had to be removed; the steam still issues from this vent at a temperature of 96.7° C. (205° F.).

THE CALIFORNIA GEYSERS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Dr. Winslow Anderson and Professor Thomas Price). | | | | | |
|---|---|---|---|---|---|---|
| | Indian Spring, No. 1. | Indian Spring, No. 2. | Hot Alum Spring. | Bathing Spring. | Hot Sulphur Spring. | Devil's Tea Kettle. |
| Potassium sulphate ($K_2SO_4$) | 3.59 | | | | | |
| Sodium bisulphate ($NaHSO_4$) | ... | 292.92 | ... | ... | ... | 1679.52 |
| Sodium sulphate ($K_2SO_4$) | 56.39 | ... | ... | 67.75 | 45.51 | |
| Magnesium sulphate ($MgSO_4$) | ... | 1015.14 | 703.68 | 4.45 | ... | 668.83 |
| Calcium sulphate ($CaSO_4$) | ... | 109.84 | 166.56 | 12.49 | 41.89 | 533.15 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | 389.78 | 2032.33 | 31.99 | 41.89 | 533.15 |
| Ferrous sulphate ($FeSO_4$) | ... | ... | 492.94 | 4.28 | 2.74 | |
| Calcium metaborate ($CaB_2O_4$) | ... | ... | ... | 121.48 | 113.27 | |
| Magnesium metaborate ($MgB_2O_4$) | 430.80 | ... | ... | 311.40 | 296.17 | |
| Sodium bicarbonate ($NaHCO_3$) | 41.55 | | | | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | trace | ... | trace | | |
| Ferrous bicarbonate ($FeHCO_3$) | ... | 1.94 | | | | |
| Aluminum oxide ($Al_2O_3$) | 3.08 | | | | | |
| Sulphuric acid ($H_2SO_4$) | ... | 398.66 | 98.38 | ... | ... | 1893.31 |
| Boric acid ($H_3BO_3$) | ... | ... | ... | 5.63 | | |
| Silicic acid ($H_2SiO_3$) | 77.34 | 209.60 | 309.35 | ... | 141.66 | 219.52 |
| Silica ($SiO_2$) | ... | ... | ... | 136.54 | | |
| Total solids | 612.75 | 2417.88 | 3803.24 | 696.01 | 683.13 | 5528.48 |
| Temperature, °C. | 43.3 | 37.8 | 58.9 | 57.8 | 60 | 100 |
| Gases: Sulphuretted hydrogen | Sat'd | Sat'd | Sat'd | Sat'd | Sat'd | Sat'd |

The Indian Spring, No. 1, medicinal classification, weak alkaline b or (−Ab, −T2), thermic, sulphuretted. This is a moderately mineralized, thermic, magnesic, borated, acid water, sulphuretted.

The Indian Spring, No. 2, medicinal classification, weak acid, sulphuric 1.7, aluminic 1.4, sodic 0.5, weak sulphated b 4 or (−AcS 1.7, Al 1.4, Na 0.5, −S4), thermic, sulphuretted. This is a moderately highly mineralized, thermic, magnesic, aluminic, calcic, sulphated, acid water, sulphuretted.

The Hot Alum Spring, No. 2, medicinal classification, acid aluminic 2, weak sulphated 2 or (AcAl 2, −S2), thermic sulphuretted. Chemical classification: This is a moderately highly mineralized, thermic, aluminic, magnesic, ferric and calcic, sulphated, acid water, sulphuretted.

The Bathing Spring, medicinal classification, weak alkaline b or (−Ab, −T2), thermic sulphuretted. Chemical classification: This is

a moderately mineralized, thermic, magnesic, calcic, borated, light, saline water, sulphuretted.

The Hot Sulphur Spring, medicinal classification, weak alkaline b or (−Ab, −T2), thermic sulphuretted. This is a moderately mineralized, thermic, magnesic, calcic, borated, acid water, sulphuretted.

The Devil's Tea Kettle, medicinal classification, acid sulphuric 2.5 or (AcS 2.5), thermic sulphuretted. This is a moderately highly mineralized, thermic, sodic, aluminic, magnesic, calcic, sulphated, acid water, sulphuretted.

Several hundred feet up the Pluton River there has been constructed a very large and commodious bathing establishment, which spans the river. It is thoroughly modern in construction and equipment. The hot sulphurous vapors are piped directly from the vents to the different parts of the bathing establishment, where the bather can enjoy the medicinal effects of the sulphurous fumes and steam vapors at any desired temperature. The waters from the Bathing Spring, on account of the large amount of borates held in solution, are remarkable and exert a pleasing unctuous feel to the surface of the body while in the bath. The borates and sulphates render the skin soft, white and pliable; it has proven highly beneficial in many cutaneous, syphilitic and strumous contaminations, rheumatism and chronic joint diseases. Internally the action of the water is laxative, diuretic and diaphoretic.

THE CALIFORNIA GEYSERS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Winslow Anderson and Thomas Price). | | | | | |
|---|---|---|---|---|---|---|
| | Lemonade Spring. | Witch's Cauldron Spring. | Hot Acid Spring. | Hot Alum Spring. | Iron Spring, No. 1. | Pluton Spring. |
| Potassium bisulphate ($KHSO_4$) | 128.83 | 7.19 | 19.50 | | | |
| Potassium sulphate ($K_2SO_4$) | | | | | | |
| Sodium bisulphate ($NaHSO_4$) | 922.41 | 681.49 | 164.59 | 87.95 | | |
| Sodium sulphate ($Na_2SO_4$) | ... | ... | ... | ... | ... | 52.26 |
| Magnesium sulphate ($MgSO_4$) | 695.89 | 164.60 | 1561.79 | 590.12 | 43.11 | |
| Calcium sulphate ($CaSO_4$) | ... | 119.43 | 75.99 | 94.19 | 56.80 | 18.82 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 547.86 | 34.88 | 352.81 | 1101.96 | ... | 3.42 |
| Ferrous sulphate ($FeSO_4$) | 209.59 | ... | 284.54 | 125.60 | ... | 1.88 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | ... | ... | ... | 3.33 | |
| Magnesium silicate ($MgSiO_3$) | ... | ... | ... | ... | ... | 264.52 |
| Aluminum oxide ($Al_2O_3$) | ... | 4.70 | ... | ... | 2.91 | |
| Sulphuric acid ($H_2SO_4$) | 544.43 | ... | 2641.27 | 110.34 | | |
| Hydrochloric acid (HCl) | 20.36 | | | | | |
| Silicic acid ($H_2SiO_3$) | 282.32 | 75.79 | 361.19 | 295.32 | 16.93 | 295.15 |
| Silica ($SiO_2$) | ... | ... | ... | ... | ... | 180.01 |
| Total solids | 3251.69 | 1088.08 | 5461.68 | 2405.48 | 123.08 | 816.06 |
| Temperature, °C. | 40 | 100 | 60 | 57.8 | 12.2 | 58.9 |
| Gases: | | | | | | |
| Sulphuretted hydrogen | Sat'd | Sat'd | Sat'd | Sat'd | Sat'd | Sat'd |

The Lemonade Spring, medicinal classification, acid sulphuric 1.5 or (AcS 1.5), thermic, sulphuretted. This is a moderately highly mineralized, thermic, sodic, magnesic, aluminic, sulphated, acid water, sulphuretted.

The Witch's Cauldron Spring, medicinal classification, weak acid sodic 2 or (−AcNa2), thermic, sulphuretted. This is a moderately mineralized, thermic, sodic, magnesic, calcic sulphated, acid water, sulphuretted.

The Hot Acid Spring, medicinal classification, acid sulphuric 2.5 or (AcS 2.5), thermic, sulphuretted. This is a moderately highly mineralized, thermic, magnesic, aluminic, ferruginous, acid water, sulphuretted.

The Hot Alum Spring, medicinal classification, acid aluminum sulphate 1.7 or (AcAl 1.7), thermic, sulphuretted. This is a moderately highly mineralized, thermic, aluminic, magnesic and ferruginous, sulphated, acid water, sulphuretted.

The Iron Spring, No. 1, medicinal classification, sulphuretted. This is a lightly mineralized, calcic, magnesic, sulphated, saline water, sulphuretted.

The Pluton Spring, medicinal classification, weak mineralization 2 or (—T2), thermic, sulphuretted. This is a moderately mineralized, thermic, magnesic, silicated, acid water, sulphuretted.

## Calistoga Springs.

*Napa County.*)

*Postoffice,* Calistoga. *Location,* in western California; north of San Francisco, 60 miles; west of Sacramento, the capital city, 55 miles. *Situation,* at the eastern foothills of the Coast Range of mountains, at an elevation of about 1000 feet above sea level. *Access,* via the Southern Pacific Railway. *Hotel,* the old hotel was burned in the late seventies; a smaller resort hostelry now takes care of visitors. There is a bathing establishment. The springs show the following analysis:

CALISTOGA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Winslow Anderson). | |
|---|---|---|
| | Calistoga Spring. | Calistoga Pool. |
| Sodium chloride (NaCl) | 334.99 | 394.49 |
| Magnesium chloride ($MgCl_2$) | ... | 6.80 |
| Calcium chloride ($CaCl_2$) | 94.24 | 16.41 |
| Potassium iodide (KI) | trace | 3.59 |
| Sodium iodide (NaI) | 1.26 | 12.48 |
| Sodium sulphate ($Na_2SO_4$) | 29.82 | 118.02 |
| Magnesium sulphate ($MgSO_4$) | 49.59 | 19.83 |
| Calcium sulphate ($CaSO_4$) | 10.77 | 21.37 |
| Potassium bicarbonate ($KHCO_3$) | ... | 21.05 |
| Sodium bicarbonate ($NaHCO_3$) | 141.39 | 60.66 |
| Manganese bicarbonate ($Mn[HCO]_{23}$) | ... | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 8.03 | 12.31 |
| Silica ($SiO_2$) | 77.80 | 61.73 |
| Total solids | 747.89 | 748.74 |
| Temperature, °C. | 34.8 | 49.5 |
| Gases: | | |
| Hydrogen sulphide, cc. per liter | 16.4 | 21.7 |

The Calistoga Spring, medicinal classification, weak saline (iodic) −T2 or (−Cl(I)−T2), sulphuretted. This spring shows a moderately mineralized, thermic, sodic, muriated, sulphated, bicarbonated, saline (iodic water), sulphuretted, possessing diuretic, alterative and tonic properties.

The Swimming Pool Spring, medicinal classification, weak saline (iodic) −T2 or (−Cl(I)−T2), thermic sulphuretted. This is a moderately mineralized, thermic, sodic, muriated, sulphated and bicarbonated saline (iodic) water, sulphuretted, possessing diuretic tonic and alterative properties. The water has gained considerable reputation in the treatment of obstinate cases of rheumatism and syphilis.

### Cook's Springs.

(*Colusa County.*)

*Postoffice,* Ladoga. *Location,* in the western part of the state; northwest of San Francisco, 120 miles; east of Lakeport, 22 miles; north of Sacramento, 100 miles. *Situation,* in Indian Valley, amid the foothills of the Coast Range of mountains, at an elevation of 1600 feet above the sea level, overlooking the beautiful Sacramento Valley to the eastward. *Access,* via the Southern Pacific Railway to Williams, thence by motor bus, over a graded macadam highway leading through a wonderful scenic region of great charm and natural beauty, 30 miles to the springs. *Hotel,* there is a large commodious three-story resort hostelry with modern conveniences. The bathing establishment is a modern structure, with the latest scientific equipment for the practice of hydrotherapy and balneotherapy. The medical department is under the direction of a competent physician with a trained corps of assistants. Connected with the hotel and bathing establishment, and under the same management, is a sanitarium department offering all the advantages of a city hospital, with departments especially equipped with the latest physiotherapeutic apparatus. Dietotherapy is given special attention for those who are under treatment. There are 3 highly mineralized springs in the area, all issuing from serpentine and altered sandstone faults containing veinlets of calcite. The supposition is that this serpentine rocky formation is present beneath the surface, and that the calcite may yield the large amount of carbon-dioxide gas in the waters. The analyses on page 247 shows the mineralization of 2 of the more important springs.

Dead Shot Spring, medicinal classification, alkaline ab2, saline (iodic) or (Aab2, Cl(1)), carbon-dioxated. This is a moderately highly mineralized, sodic, magnesic, bicarbonated and sodic muriated, alkaline-saline (iodic, bromic) water, carbon-dioxated, possessing diuretic, antacid, alterative and tonic properties.

Sweet Spring, medicinal classification, alkaline b2, weak saline 3 or (Ab2−Cl3) (iodic), carbon-dioxated. This is a moderately highly min-

eralized, magnesic, bicarbonated and sodic muriated, alkaline (iodic) water, carbon-dioxated, possessing diuretic, antacid and alterative properties. The waters from both springs are said to be very highly radio-active, increasing the therapeutic potency of the waters, which are highly endorsed by the profession in a wide range of diseased conditions of the stomach, alimentary canal, kidneys, bladder, liver and gall ducts and in run-down conditions where a reconstructive alterative tonic is indicated.

COOK'S SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Curtis and Tomkins). Dead Shot Spring. | Sweet Water Spring. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | 156.00 | 17.50 |
| Lithium chloride (LiCl) | 15.90 | 47.00 |
| Potassium chloride (KCl) | 169.00 | 68.00 |
| Sodium chloride (NaCl) | 2371.00 | 1342.00 |
| Potassium bromide (KBr) | 14.30 | trace |
| Potassium iodide (KI) | 19.70 | 16.10 |
| Sodium sulphate ($Na_2SO_4$) | none | none |
| Sodium nitrate ($NaNO_3$) | trace | 165.00 |
| Sodium nitrite ($NaNO_2$) | trace | 51.60 |
| Sodium tetraborate ($Na_2B_4O_7$) | 181.00 | 104.00 |
| Disodium arsenate ($Na_2HAsO_4$) | trace | trace |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 1.18 | 0.95 |
| Sodium bicarbonate ($NaHCO_3$) | 2370.00 | 90.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1243.00 | 3305.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 154.00 | 215.00 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.26 | 0.96 |
| Aluminum oxide ($Al_2O_3$) | 2.00 | 1.70 |
| Silica ($SiO_2$) | 85.00 | 94.00 |
| Total solids | 6783.34 | 5518.79 |
| Gases: | | |
| Hydrogen sulphide ($H_2S$) | none | none |
| Carbon dioxide (0° C. and 760 mm. pressure), cc. per liter | 860 | 496 |
| Carbon dioxide set free on evaporation of bicarbonates to dryness, cc. per liter | 524 | 544 |

## Elsinore Hot Springs.

(*Riverside County.*)

*Postoffice*, Elsinore. *Location*, in southern California; north of the Mexican boundary line, 75 miles; south of the Sequoia National Park, 180 miles. *Situation*, on the shores of beautiful Lake Elsinore, at an elevation of about 1300 feet above sea level. *Access*, via Elsinore Depot on the Southern Pacific and via the main inland boulevard, half way between Los Angeles and San Diego, which is a delight for motorists. *Hotel*, there is a commodious resort hostelry with modern conveniences. The bathing establishment is modern in construction and equipment, completely fitted for every form of physiotherapeutic treatment, all under the direction of a competent physician

and corps of trained masseurs and masseuses. The hotel and bathing establishment are all under the same management. The springs, 2 in number, 1 of which is a sulphur water and the other has the following mineralization as shown by analysis below. One pleasing feature of the waters is that the temperature is very near that of the body, 31.4° C., and the waters do not have to stand before drinking or for use in bathing. There are more than 100 springs in this county, some hot and others cold. The cold springs are carbonated, containing soda, magnesia and iron; the hot springs are sulphurous and carry calcium, borax and magnesia; there are also a few mud (hot) springs. This valley seems peculiarly situated and plentifully supplied with mineral waters to become a popular place of resort in the near future.

ELSINORE HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, California State University). |
|---|---|
| Sodium chloride (NaCl) | 355.60 |
| Sodium sulphate ($Na_2SO_4$) | 405.52 |
| Potassium bicarbonate ($KHCO_3$) | 171.10 |
| Sodium bicarbonate ($NaHCO_3$) | 37.08 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 664.41 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 5264.41 |
| Ferric oxide and alumina ($FeO_3$, $Al_2O_3$) | 171.11 |
| Silica ($SiO_2$) | 88.92 |
| Tota solids | 7158.15 |

Medicinal classification, alkaline b3 or (Ab3). The analysis shows this to be a moderately highly mineralized, calcic, bicarbonated alkaline (ferruginous) water, possessing diuretic, antacid, eliminative and tonic properties. The water is highly recommended in the treatment of constipation and in catarrhal disorders of the intestinal tract and for hepatic engorgement, and especially for gastric disorders due to acidity and hyperacidity. The water has been used with pleasing results in sciatica, neuritis, arthritis, neuralgia and kindred affections.

## Glen Alpine Springs.

### (*El Dorado County.*)

*Postoffice,* Tallac, Lake Tahoe. *Location,* in eastern California; west of Carson City, the capital of Nevada, 40 miles; northeast of Sacramento, California's capital, 120 miles. *Situation,* in a wild, rugged gorge of mountain fastness, which runs back from Lake Tahoe, a distance of 10 miles, filled throughout its entire length with varied and weird scenes of picturesque beauty and sublime grandeur, terminating abruptly in a glacial amphitheatre in which the springs are located, at an elevation of 6700 feet above sea level. The mighty glacier which held sway here countless centuries ago, and went grinding, crushing and cutting its way down, forming the beds in which

now lie the beautiful lakes, in a chain of which Tahoe is the last link. *Access*, via the Southern Pacific Railway to Lake Tahoe, thence by steamer to Tallac and from there by motor a distance of 7 miles to the springs; or via the Pierce Arrow Motor Stage from Sacramento, which passes within 2 miles of the springs. The Lincoln Highway traverses this section, and is the delight of motorists. *Hotel*, the hotel and cottages furnish comfortable accommodations for 150 guests; modern conveniences. Bathing conveniences, tubs and showers only. The main spring rises in a flat of this amphitheatre, in a protected spring house, which serves as a convenient and serviceable drinking fountain. The analysis below shows the mineralization:

GLEN ALPINE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, California State University). |
|---|---|
| Sodium chloride (NaCl) | 362.00 |
| Calcium sulphate ($CaSO_4$) | 69.11 |
| Sodium metaborate ($NaBO_2$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 887.20 |
| Potassium bicarbonate ($KHCO_3$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 275.91 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1249.08 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 49.86 |
| Aluminum oxide ($Al_2O_3$) | 24.45 |
| Silica ($SiO_2$) | 42.75 |
| Total solids | 2950.36 |
| Temperature, °C. | 14 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 472.3 |
| Flow in gallons per day | 2400 |

Medicinal classification, alkaline ab, weak saline, very weak ferruginous or (Aab, $-Cl--Fe0.5$), carbon-dioxated. The analysis shows this to be a moderately highly mineralized, calcic, sodic and magnesic bicarbonated alkaline (ferruginous) water, carbon-dioxated, possessing diuretic, antacid, gently aperient, tonic and alterative properties. The medicinal qualities make it of use in the treatment of digestive disturbances due to acidity and hyperacidity, in laxity of bowel action and in renal and vesical disorders. The iron and aluminum make it of value as a tonic where the hemoglobin content of the blood is below normal. Anemic and chlorotic girls would be benefited by a course of this water.

## Harbin Hot Sulphur Springs.

(*Lake County.*)

*Postoffice*, Harbin Springs via Middletown. *Location*, in western western California; north of San Francisco, 70 miles; west of Sacramento, the capital city, 65 miles. *Situation*, at the base of a spur of the Coast Range of mountains, at an elevation of 1500 feet above sea

level. *Access*, via the Southern Pacific Railway to Calistoga, thence by motor over graded macadam highways, through a beautiful picturesque region clothed in perpetual evergreen, of pine, spruce and fir, to the springs. *Hotel*, there are good hotel accommodations for 200 guests. Modern conveniences, bath house and gymnasium. The waters on analysis shows the following mineralization:

HARBIN HOT SULPHUR SPRINGS.

| Hypothetical combinations | Parts per 1,000,000 (Analyst, Dr. Winslow Anderson). | |
|---|---|---|
| | Hot Sulphur Spring. | Chalybeate Spring. |
| Potassium chloride (KCl) | ... | trace |
| Sodium chloride (NaCl) | 394.15 | 127.25 |
| Sodium sulphate ($Na_2SO_4$) | 121.74 | 89.77 |
| Magnesium sulphate ($MgSO_4$) | 204.17 | 104.48 |
| Calcium sulphate ($CaSO_4$) | 251.09 | trace |
| Ferrous sulphate ($FeSO_4$) | 39.82 | |
| Sodium arsenate ($Na_2HAsO_4$) | 1.19 | |
| Potassium bicarbonate ($KHCO_3$) | 48.20 | 45.92 |
| Sodium bicarbonate ($NaHCO_3$) | 150.14 | 395.37 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 138.70 | 115.24 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 252.08 | 56.25 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 32.07 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 27.36 | 13.88 |
| Silica ($SiO_2$) | 47.21 | 24.11 |
| Total solids | 1676.75 | 1004.34 |
| Gases: | | |
| Carbon dioxide, cc. per liter | 36 | 80 |
| Hydrogen sulphide, cc. per liter | 78 | |
| Temperature, °C. | 50 | |

The Harbin Hot Sulphur Spring, medicinal classification, weak alkaline b, weak saline, weak sulphated or (−Ab, −Cl, −S, −T4), thermic, sulphuretted. This is a moderately highly mineralized, thermic, sodic, muriated, sulphated, bicarbonated, saline (arsenated) water, sulphuretted, possessing diuretic, laxative, tonic and alterative properties.

The Harbin Chalybeate Spring, medicinal classification, weak alkaline b, very weak ferruginous (0.5) or (−Ab, − −Fe 0.5, −T2). This is a moderately mineralized, sodic, muriated, sulphated, bicarbonated, saline (ferruginous) water, carbon-dioxated, possessing diuretic, antacid and tonic properties. These waters are useful adjuvants in the treatment of anemia, chlorosis and in dyspeptic conditions due to acidity. There are 2 other springs, the Magnesia and Arsenic. The last-named has some reputation in syphilitic, glandular and skin diseases.

## Highland Springs.

(*Lake County.*)

*Postoffice,* Highland Springs. *Location,* in western California; slightly northwest from San Francisco, 100 miles; northwest of Sacra-

mento, the capital city, 95 miles. *Situation*, among the eastern foothills of the St. Phelena Range of mountains, in a sequestered little valley, through which runs a beautiful little mountain stream in its rush to join the Sacramento River to the eastward. The elevation is 1700 feet above the Pacific Ocean. Clear Lake, a beautiful sheet of water, 25 miles long by 6 miles wide, lies to the north at an elevation of 1200 feet above tide water, smiling in the embrace of mountains on all sides. "Uncle Sam" lifts his pinnacle 3200 feet to meet the horizon, overlooking Highland Springs in the heart of the "Switzerland of America." *Access*, via Hopland on the Northwestern Pacific Railway, thence by motor, over a splendid mountain highway leading through a picturesquely beautiful mountain region, 16 miles to the springs; or via Calistoga on the Southern Pacific Railway, thence through an equally interesting region to the springs. *Hotel*, there is a modern resort hostelry with ample conveniences; besides there are a number of cottages which furnish additional accommodations. The season runs from May to October. The springs in this area are about 25 in number; they all issue mainly from crushed sandstone and shale and perhaps from serpentized rocks beneath. The temperature suggests that at some remote period crushing or other forceful movements took place in this vicinity which gave rise to the springs. We present herewith analyses of 5 of the more important of the springs in this group:

HIGHLAND SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Winslow Anderson). | | | | |
|---|---|---|---|---|---|
| | Neptune Spring. | Diana Spring. | Seltzer Spring. | Dutch Spring. | Magic Spring. |
| Sodium chloride (NaCl) | 28.23 | 33.11 | 11.46 | 30.11 | 26.18 |
| Sodium biborate ($Na_2B_4O_7$) | 9.06 | 9.58 | ... | ... | 4.79 |
| Potassium bicarbonate ($KHCO_3$) | 17.54 | 30.65 | 8.56 | 13.34 | 14.55 |
| Sodium bicarbonate ($NaHCO_3$) | 382.41 | 444.31 | 274.62 | 267.33 | 401.98 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1767.97 | 1380.09 | 580.88 | 1183.85 | 1213.75 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 646.76 | 1194.79 | 893.80 | 980.75 | 859.47 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace | trace. | trace | trace | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 46.20 | 43.28 | 39.64 | 42.41 | 33.82 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 6.61 | 6.65 | trace | ... | 1.94 |
| Lithium bicarbonate ($LiHCO_3$) | trace | trace | | | |
| Aluminum oxide ($Al_2O_3$) | 20.53 | 4.96 | 29.93 | 2.05 | 2.39 |
| Silica ($SiO_2$) | 136.19 | 122.68 | 87.77 | 123.53 | 109.50 |
| Total solids | 3061.50 | 3270.10 | 1926.66 | 2643.37 | 2668.37 |
| Temperature, °C. | 27 | 28 | 18 | 25 | 26 |
| Flow in gallons per day | 3120 | 3120 | 1200 | 1440 | 14,400 |

Neptune Spring, medicinal classification, Alkaline b, very weak ferruginous 0.5 or (Ab, ——Fe0.5, T2). Diana Spring, medicinal classification, alkaline b2, very weak ferruginous (0.5) or (Ab2, ——Fe 0.5).

The analyses of these two springs shows a moderately, highly mineralized, magnesic, sodic, calcic and ferruginous bicarbonated alkaline water, possessing diuretic, antacid, tonic and alterative properties. The waters of these two springs have been used with success in gastric disturbances due to acidity and hyperacidity and in run-down conditions where an iron tonic is indicated, such as anemia, chlorosis and wherever the coloring matter of the blood is below normal.

The Seltzer and Dutch Springs, medicinal classification, alkaline b, very weak ferruginous (0.5) or (Ab, − −Fe0.5). These are moderately highly mineralized, magnesic, sodic, calcic and ferruginous alkaline waters, possessing similar therapeutic properties to the other two springs.

The Magic Spring, medicinal classification, alkaline b or (Ab). This is a moderately highly mineralized, magnesic, calcic and sodic ferruginous, bicarbonated, alkaline (baric) water, possessing diuretic, antacid, tonic and alterative properties. It is said to act well in gastro-intestinal disorders, hepatic congestion and irritations of the bladder and kidneys.

The Highland Spring, with its charming picturesque surroundings and its excellent climatic advantages and the excellent alkaline waters found here, peculiarly make it a resort for run-down conditions generally.

## Howard Spring.

(*Lake County.*)

*Postoffice*, Putah via Middletown. *Location*, in western California; north of San Francisco, 72 miles; west of Sacramento, the capital city, 60 miles; south of Redding, 115 miles. *Situation*, in a small basin, at an elevation of 2220 feet above sea level. *Access*, via the Southern Pacific, to Calistoga, thence by motor over good roads to the springs. *Hotel*, the hotel is modern with up-to-date conveniences for the comfort of guests. The springs number about 42, of which 26 are improved and we present the analyses of 5 of the more important.

No. 1, Excelsior Spring, medicinal classification, weak alkaline a2 saline or (−Aa2, Cl), carbon-dioxated. This is a moderately highly mineralized, lithic, sodic, muriated and bicarbonated alkaline-saline (ferruginous) water, carbon-dioxated. This spring is somewhat similar to some of the Saratoga (N. Y.) Springs. On comparing the analyses, it will be observed that the Saratoga Excelsior carries a greater percentage of sodium chloride, while the Howard Excelsior content of sodium bicarbonate is twice as great. The water possesses diuretic antacid and laxative properties. The high percentage of lithium, 142 mg. per liter, gives the water antilithic and active solvent properties and makes it a valuable kidney and bladder water.

HOWARD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. W. T. Wenzell). | | | | |
|---|---|---|---|---|---|
| | Excelsior Spring, No. 1. | Twins Spring, No. 2. | Eureka Spring, No. 3. | Neptune Spring, No. 4. | Soda Spring, No. 5. |
| Lithium chloride (LiCl) | 142.78 | 0.51 | 1.52 | 1.02 | trace |
| Potassium chloride (KCl) | 19.32 | 337.04 | 338.61 | 250.34 | 219.05 |
| Sodium chloride (NaCl) | 1738.55 | 529.41 | 610.47 | 506.33 | 160.29 |
| Sodium bicarbonate ($NaHCO_3$) | 583.11 | 1264.88 | 1459.48 | ... | 645.01 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 48.05 | 1951.11 | 1885.27 | 1254.11 | 1014.37 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 107.73 | 186.04 | 99.86 | 549.59 | 609.44 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 31.63 | 19.49 | | | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.51 | 2.56 | 86.35 | 6.66 | 3.76 |
| Silica ($SiO_2$) | 224.01 | 158.00 | 58.14 | 142.14 | 118.84 |
| Total solids | 2895.69 | 4449.04 | 4539.70 | 2710.19 | 2770.76 |
| Temperature, °C. | 24.4 | 38.9 | 43.3 | 30.0 | 15.6 |
| Gases: | | | | | |
| Carbon dioxide, cc. per liter | 462 | 264 | 517 | 414 | 403 |

No. 2, Twin Spring, medicinal classification, alkaline ab2, weak saline 2 or (Aab2, −Cl 2), thermic, carbon-dioxated. This is a moderately highly mineralized, thermic, magnesic, sodic, bicarbonated and muriated alkaline-saline (ferruginous) water, carbon-dioxated, possessing diuretic and laxative properties. It is useful in the treatment of habitual constipation, chronic digestive disturbances and in certain disorders of the liver and kidneys.

No. 3, Eureka Magnesia Spring, medicinal classification, alkaline ab2, weak saline 2 or (Aab2, −Cl 2), thermic, carbon-dioxated. This is a moderately highly mineralized, thermic, sodic, magnesic, bicarbonated and muriated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid and tonic properties.

No. 4, Neptune Bohemia Spring, medicinal classification, alkaline b, weak saline 2 or (Ab, −Cl 2), carbon-dioxated. This is a moderately highly mineralized, magnesic, sodic, bicarbonated and muriated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, laxative and tonic properties.

No. 5, Soda Spring, medicinal classification, alkaline b or (Ab), carbon-dioxated. This is a moderately highly mineralized, calcic, sodic, magnesic bicarbonated alkaline water, carbon-dioxated, possessing diuretic antacid and slight tonic properties. It is heavily charged with carbonic acid gas and makes a pleasing, cooling refreshing draught.

The bathing establishment is modern in construction and equipment, with competent masseur and masseuses in attendance.

## Mono Lake and Paoha Island Springs.

(*Mono County.*)

*Postoffice,* Mono Lake. *Location,* only a few miles from the northeast corner of Yosemite National Park; east of Stockton, 130 miles; west of Tonepah, Nevada, 142 miles; south of Bridgeport, 23 miles. *Situation,* in the great Mono Basin, 6440 feet above sea level. The views in the rough and rugged country are grand and impressive. Mono Lake, an inland sea, 14 miles wide and 16 miles long, covers an area of 150 square miles; in the lake are two islands and a number of islets. Paoha Island, one of the largest, comprises an area of 1400 acres of rolling, grazing lands, and is 7 miles off shore from Mono Inn. This island and inn forms a delightful setting for a "health shrine;" it is situated atop a crested elevation and surrounded on all sides by snow-capped mountains and presents a vista of great charm and beauty. *Access,* auto stages connect with the railroad at Bishop, a distance of 71 miles, and at Minden, Nevada, 98 miles; franchises are pending for a line of auto stages from Benton, a distance of 48 miles. *Hotels,* there is a modern western resort hotel, with conveniences for the comfort and entertainment of the guests.

MONO LAKE AND PAOHA ISLAND SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Geological Survey). | |
|---|---|---|
| | Warm Spring. | Mono Lake. |
| Potassium chloride (KCl) | 120.3 | 1,834.2 |
| Sodium chloride (NaCl) | 279.9 | 18,506.8 |
| Sodium sulphate ($Na_2SO_4$) | 463.1 | 9,869.0 |
| Sodium borate ($Na_4B_4O_7$) | ... | 200.0 |
| Sodium bicarbonate ($NaHCO_3$) | 287.3 | 34,150.1 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 366.9 | 334.9 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | ... | 81.0 |
| Calcium silicate ($CaSiO_3$) | 171.1 | |
| Aluminum oxide ($Al_2O_3$) | 1.8 | 3.0 |
| Silica ($SiO_2$) | 33.6 | 70.0 |
| Total solids | 2724.0 | 65,049.0 |
| Temperature, ° C. | | |

The Warm Spring, medicinal classification, weak alkaline ab, weak saline, weak sulphate or (−Aab, −Cl, −S). This is a moderately highly mineralized, sodic, magnesic, bicarbonated, sulphated and muriated alkaline-saline water, carbon-dioxated, possessing diuretic antacid, slight laxative and alterative properties.

Mono Lake, medicinal classification, strong alkaline a3.5, strong salines, strong sulphate or (+Aa3.5, +Cl2, +S). The water from Mono Lake is a very highly mineralized, sodic, muriated, sulphated, bicarbonated water.

The analyst of the U. S. Geological Survey, in his report on these waters, says: "At Hot Springs Cove, on the eastern side of Paoha Island, a thermal spring of considerable size comes to the surface just within the margin of the lake." The temperature of this spring is 43.6° C. (110° F.). Although of great volume, its position is rendered conspicuous, especially in winter, by the column of steam arising from it. On top of the steep slope of volcanic rock immediately above this spring, vapors with a temperature of 66.5° C. (150° F.), escape from numerous holes and crevices of the nature of fumaroles. On cold days the vapor ascending from these vents can sometimes be seen for many miles. At times the position of the vents is indicated only by a thin wreath of vapor, but occasionally a column of steam, hundreds of feet high, may be observed to rush upward every few minutes, indicating apparently that the orifice sometimes becomes clogged and are cleared by an eruption. Besides this spring, there are numerous other thermic springs extending around the border of Hot Spring Cove and on and around Hot Spring Peninsula for over $\frac{1}{4}$ mile. There is no noticeable variation in the flow of steam from the furmaroles or vents. The mineral production of salts, known as Mono Salts are obtained by taking the water from this thermic spring, or from where it enters the lake, and evaporating it in suitable vats placed over the hot steam vents or furmaroles.

It is assumed that these hot springs are largely responsible for a large amount of the mineral contents of Mono Lake. The thermal spring on the western shore of Hot Spring Cove has a bold flow. These springs are still at and above the margin of the waters in the lake, though it has risen nearly 30 feet since the geological report was made and has been constantly rising for the past fifty-eight years. All of these springs, except one are under the surface of the waters of Mono Lake. On the western side of Paoha Island is a hot well some 2600 feet deep, with a temperature of 36.7° C. (97° F.). The water from this well, though hard, is a good potable water. During the cold weather many square miles of the lake surface is covered with vapors given off so abundantly as to cause a winter fog in Mono Basin. This would indicate large numbers of thermic springs of considerable size. At times the atmosphere for several feet above the surface of the water appears to be disturbed by radiations that look like heat waves, but as this occurs during times when the heat is not sufficient to cause this phenomenon it must be due to other causes.

One of the remarkable features of this lake is the presence of fresh-water springs, holding in solution small quantities of calcium carbonate, which precipitates and deposits around the openings of the springs, forming irregular cone-shaped structures clustered together in columns; these V-shaped structures rise from the bottom of the lake in lengths of from 10 to 40 feet, and extend some distance above the surface of the lake. In the center of the columns are small openings through which flow pure sweet fresh water. The waters of Mono

Lake and the thermic springs on Paoha Islands are evaporated over the hot-steam vents in the crust of Paoha Island and are marketed in pound packages; this powder is a pure white, almost impalpable powder, and said to have great curative properties and are of value in the treatment of gastric ulcer and other gastro-intestinal disorders.

For centuries, prior to the coming of the Europeans, the red man knew and made use of the waters of Mono Lake, both internally and for bathing purposes. The soldiers of the early days are said to have used these waters for feet troubles and for distressing conditions of the skin and for rheumatic disorders. Many western physicians highly endorse the waters and salts in a wide variety of diseased conditions.

## Mok Hill Mineral Springs.

(*Calaveras County.*)

*Postoffice,* Mokelumme Hill. *Location,* in central California; southeast of Sacramento, the capital city, 50 miles; southwest of Carson City, the capital of Nevada, 90 miles. *Situation,* in the valley of the Mokelumme River, at an elevation of 1200 feet above sea level. *Access,* via the Southern Pacific Railway or via motor over splendid highways, leading through a picturesque mountainous country. *Hotel,* there are no accommodations for guests. The waters are bottled and shipped commercially. The analysis below shows the mineralization.

MOK HILL MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. W. Herms). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 980.3 |
| Magnesium chloride ($MgCl_2$) | 2850.4 |
| Calcium sulphate ($CaSO_4$) | 1090.6 |
| Magnesium sulphate ($MgSO_4$) | 1560.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1970.4 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 36.4 |
| Total solids | 8488.8 |

Medicinal classification, alkaline b, saline 2, sulphate or (Ab, Cl 2, S). The analysis shows this to be highly mineralized, magnesic and calcic sulphated and muriated saline water, possessing diuretic, antacid and slight laxative properties. This water should be useful in the treatment of digestive disturbances due to acidity and in catarrhal diseases of the alimentary tract; likewise it should exert a pleasing effect upon irritable conditions of the renal and vesical organs. The waters are bottled and shipped extensively. The bottling plant is modern in construction and equipment.

## Napa Soda Springs.

(*Napa County.*)

*Postoffice*, Napa Soda Springs. *Location*, in midwestern California north of San Francisco, 52 miles; southwest of Sacramento, the capital city, 65 miles; north of Napa City, the county seat, 5 miles. *Situation*, on the east side of the beautiful Napa Valley, lying in the southwestern slope of the Coast Range of mountains, at an elevation of 1000 feet above sea level, overlooking the charming Napa Valley, with its fertile farms, orchards and vineyards. *Access*, via Napa Depot on the Southern Pacific Railway, thence a distance of 5 miles by auto to the springs. *Hotel*, this caravansary has modern conveniences. The kitchen is a model of sanitation; the cuisine is excellent. There are perhaps some 25 or more springs in the area. We present herewith the analyses of the following which shows the mineralization, which is to be expected, for the springs issue from serpentine strata in an area of altered sediments that form the principal rocks in this region.

NAPA SODA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Winslow Anderson). Pagoda Spring. | Iron Spring. | Lemon Spring. |
|---|---|---|---|
| Sodium chloride (NaCl) | 122.09 | 88.97 | 80.75 |
| Potassium chloride (KCl) | ... | ... | trace |
| Sodium sulphate ($Na_2SO_4$) | 27.70 | 31.45 | 13.00 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 252.28 | 224.58 | 389.63 |
| Potassium bicarbonate ($KHCO_3$) | trace | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 723.58 | 723.99 | 698.22 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 300.19 | 300.36 | 248.62 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 216.34 | 216.31 | 244.79 |
| Aluminum oxide ($Al_2O_3$) | 9.75 | 10.20 | 12.66 |
| Silica ($SiO_2$) | 12.66 | 10.60 | 14.20 |
| Total solids | 1664.59 | 1606.46 | 1741.87 |
| Temperature, °C. | 20 | 20 | 19.4 |

Pagoda Spring, medicinal classification, weak alkaline b4, very weak ferruginous 2.5 or (−Ab4, − −Fe2.5).

Iron Spring, medicinal classification, weak alkaline b4, very weak ferruginous 2.5 or (−Ab4, − −Fe2.5).

Lemon Spring, medicinal classification, weak alkaline b4, very weak ferruginous 3 or (−Ab4, − −Fe3).

There is such a great similarity in the percentage of the predominating chemical constituents and amount of total solids that all 3 springs may be classed as one water, a moderately highly mineralized, magnesic, calcic, sodic and ferric bicarbonated alkaline water, possessing diuretic, antacid and decided tonic effects. The ferruginous salts held in solution by the carbonic acid gas are valuable in anemia, chlorosis

and in many disorders requiring iron for the constructive metamorphosis of the red blood corpuscles. The waters have been used with success in renal and vesical disorders and for women suffering from chronic metritis and ovaritis and many forms of uterine complaints this iron tonic is better borne by the stomach than almost any other chalybeate tonic. In addition to the delightful location, the splendid hotel accommodations and curative virtues of the waters, there are many attractions to claim the guests' attention, mountain climbing, motoring, swimming, pool, billiards, dancing and the usual attractions of a well-ordered clubhouse.

## Newsoms' Hot Springs.

(*San Luis Obispo County.*)

*Postoffice*, Arroyo Grande. *Location*, in southwestern California; southeast from San Francisco, 210 miles; northwest from Los Angeles, 170 miles. *Situation*, among the foothills of the western slope of the Coast Range of mountains, at an elevation of 400 feet above tide water. *Access*, via the Ocean and Pismo Division of the Southern Pacific Railway, or by motor over the splendid macadam highway from Los Angeles to San Francisco. *Hotel*, the accommodations are modern, with comfortable conveniences. The climate is delightful, one of perpetual sunshine. There are several springs in the area. The analysis below shows the mineralization of the White Sulphur Spring:

NEWSOMS' WHITE SULPHUR HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Winslow Anderson). |
|---|---|
| Sodium chloride ($NaCl$) | 70.15 |
| Potassium sulphate ($K_2SO_4$) | 49.62 |
| Sodium sulphate ($Na_2SO_4$) | 67.07 |
| Magnesium sulphate ($MgSO_4$) | 42.26 |
| Calcium sulphate ($CaSO_4$) | 12.86 |
| Potassium bicarbonate ($KHCO_3$) | 4.16 |
| Sodium bicarbonate ($NaHCO_3$) | 48.51 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 177.67 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 90.09 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 110.58 |
| Aluminum oxide ($Al_2O_3$) | 5.65 |
| Silica ($SiO_3$) | 51.67 |
| Organic matter | 4.62 |
| Total solids | 734.91 |
| Temperature, ° C. | 37.8 |
| Flow in gallons per day | 49,000 |

Medicinal classification, weak alkaline b, very weak ferruginous or (−Ab, − −Fe), thermic. The analysis shows this to be a moderately mineralized, thermic, magnesic and ferric bicarbonated alkaline-saline

water, sulphuretted. Practically two-thirds of the salts in solution are in the form of the bicarbonates of potassium, sodium, magnesium, calcium and iron and more than one-fourth are in the sulphates of potassium, sodium, magnesium and calcium. This water possesses diuretic antacid, laxative and tonic properties. The water has gained considerable reputation in the treatment of chronic rheumatism, gout and catarrhal affections of the bladder and bowels, and it has given relief in some of the chronic inflammatory skin disorders. The sulphate ions are in such combination as to induce laxative action of the bowels and the water is used in chronic constipation. It is claimed that in uterine troubles the hot sulphurous douche has been of great benefit. Warm and hot plunge and tub bathing facilities are provided.

## Paraiso Hot Springs.

(*Monterey County.*)

*Postoffice*, Paraiso Springs. *Location*, on the western border of the state in Salinas Valley; southeast of San Francisco, 150 miles; northeast of Los Angeles, 319 miles; south of Soledad, 7 miles. *Situation*, cosily tucked away by Nature in a picturesque little alcove on the western side of the Santo Lucia Range of mountains, about 1400 feet above sea level. *Access*, via Soledad Station on the Southern Pacific, thence by motor over splendid macadam highways, through a charming mountainous region of great beauty, 7½ miles to the springs. *Hotels*, the present hotel is not a new structure; it is expected, however, in the very near future a new and commodious hotel will be erected with all modern conveniences and appointments. The hotel is surrounded with cottages and bungalows for the accommodations of guests. This is an all-the-year-round resort, and each season has its special features. The winter climate is ideal for invalids and convalescents. The bathing establishment is a special feature of the resort; here are given the natural hot sulphur and soda tub baths; expert masseurs and masseuses for men and women, with separate divisions. The Paraiso Hot Springs is as old as the everlasting hills, and the value of the waters are shown in the analyses on page 260.

Hot Sulphur Spring, medicinal classification, weak sulphate 2 or (−S2, −T3), thermic, sulphuretted. This spring flows at the rate of about 1000 gallons per hour, and the analysis shows it to be a moderately mineralized, thermic, sodic, sulphated, bicarbonated saline (ferruginous) water, sulphuretted, possessing antacid, diuretic, laxative, tonic and detergent properties, and of value in the treatment of chronic rheumatism, joint diseases, syphilis and scrofula.

Hot Soda Spring, medicinal classification, weak sulphate 2 or −S2, −T3), thermic, sulphuretted. This spring flows at the rate of 1000 gallons per hour, and the analysis shows it to be a moderately mineralized, sodic, magnesic, sulphated saline water, possessing ant-

acid, diuretic and laxative properties, and of value in the treatment of diseases of the liver and gall ducts and catarrhal diseases of the intestinal tract and in glandular swellings.

PARAISO HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, Dr. W. Anderson.) Hot Sulphur Springs. | Hot Soda Spring. | (Analyst not given.) Arsenic Spring. |
|---|---|---|---|
| Sodium chloride (NaCl) | 59.850 | 47.196 | 344.359 |
| Potassium chloride (KCl) | 5.985 | ... | 152.429 |
| Magnesium chloride ($MgCl_2$) | ... | ... | 66.519 |
| Calcium chloride ($CaCl_2$) | ... | ... | 17.202 |
| Potassium sulphate ($K_2SO_4$) | ... | 14.193 | |
| Sodium sulphate ($Na_2SO_4$) | 607.050 | 634.410 | 16.911 |
| Calcium sulphate ($CaSO_4$) | 73.872 | 75.240 | 15.903 |
| Magnesium sulphate ($MgSO_4$) | ... | 37.449 | |
| Disodium arsenate ($Na_2HAsO_4$) | ... | ... | trace |
| Sodium bicarbonate ($NaHCO_3$) | 117.824 | 31.853 | 335.673 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 168.666 | 345.728 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 35.612 | 25.654 | 76.092 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | ... | 38.133 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 27.360 | | |
| Silica ($SiO_2$) | 44.802 | 28.235 | 156.157 |
| Organic matter | 33.134 | 10.200 | none |
| Total solids | 1005.489 | 1073.096 | 1565.106 |
| Gases: | | | |
| Carbonic acid, sulphuretted hydrogen, | + | + | |
| temperature, ° C. | 45.6 | 47.8 | |

+ Present.

Arsenic Spring, medicinal classification, weak alkaline ab2, weak saline or (−Aab2, −S, −T4). This spring flows less than 1000 gallons per hour, and the analysis shows a moderately highly mineralized, ferruginous, sodic, magnesic, muriated, sulphated, bicarbonated alkaline-saline water, carbon-dioxated, possessing tonic, antacid, diuretic and alterative properties. It is of value in the treatment of anemia and chlorosis and other depraved conditions of the blood and blood-making organs.

## Passo Robles Hot Springs.

(*San Luis Obispo County.*)

*Postoffice,* Passo Robles. *Location,* near the western border of the state, lying east of the Santa Lucia Mountains and the Pacific and within 16 miles of the coast, midway between San Francisco and Los Angeles, about 200 miles southeast of the former and northwest of the latter about 160 miles. *Situation,* in the beautiful valley of the Salina River, at the foothills of the Santa Lucia Range of mountains, which forms the western panorama of this valley and which protects

it from the fogs, dampness and cold winds which sometimes blow in from the sea. *Access*, via the Coast Line of the Southern Pacific Railway, and via California's excellent graded highways. *Hotel*, there is a commodious hostelry with every convenience of a metropolitan hotel. The bathing establishment is connected with the hotel, and is a model of the latest knowledge of the science of hydrotherapy and balneotherapy, under the personal supervision of a competent hydrologist with a corps of trained assistants. The equipment is of the most approved type for the practical application of hydriatic science. The interior is constructed of white marble and tile, with dressing rooms, cooling rooms, steam rooms and treatment rooms, all arranged for the comfort and convenience of the bather. The Mud Spring bath-house is separated a short distance from the hotel, being constructed directly over the spring, the hot water piercing through crevices in the rock floor of the bath-house and bubbling through the silicated mud. The analyses of the waters from these hot springs shows the following mineralization:

PASSO ROBLES HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Winslow Anderson). Sulphur Spring. | Lithia Spring. |
|---|---|---|
| Lithium chloride (LiCl) | trace | trace |
| Potassium chloride (KCl) | 26.85 | 14.02 |
| Sodium chloride (NaCl) | 439.98 | 1431.61 |
| Sodium bromide (NaBr) | trace | |
| Sodium iodide (NaI) | trace | trace |
| Sodium sulphate ($Na_2SO_4$) | 123.97 | 632.18 |
| Potassium sulphate ($K_2SO_4$) | trace | 54.55 |
| Magnesium sulphate ($MgSO_4$) | 87.38 | 19.32 |
| Calcium sulphate ($CaSO_4$) | 50.27 | 269.32 |
| Ferrous sulphate ($Fe_2SO_4$) | ... | trace |
| Sodium bicarbonate ($NaHCO_3$) | 915.43 | 200.82 |
| Potassium bicarbonate ($KHCO_3$) | 50.80 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 63.89 | 126.31 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 34.07 | 58.17 |
| Ferric oxide ($Fe_2O_3$) | 12.48 | |
| Aluminum oxide ($Al_2O_3$) | 4.27 | 13.68 |
| Silica ($SiO_2$) | 29.92 | 42.92 |
| Total solids | 1839.31 | 2862.80 |
| Gases, sulphuretted hydrogen present in liberal amounts. | | |
| Flow, gallons in twenty-four hours | 120,000 | 144,000 |
| Temperature, °C. | 42.2 | 50 |

Sulphur Spring, medicinal classification, weak alkaline a2, weak saline 2 or (−Aa3, −Cl 2), thermic, sulphuretted. This is a moderately highly mineralized, thermic, sodic, bicarbonated, sulphated alkaline-saline water, sulphuretted, possessing diuretic and alterative properties. The water is found especially serviceable in acute and chronic rheumatism, scrofulous, glandular and cutaneous diseases.

Lithia Spring, medicinal classification, weak alkaline ab, weak saline 4, weak calcic sulphate or (−Aab, −Cl 4, −CaS), thermic, sulphuretted. This is a moderately highly mineralized, thermic, sodic, muriated and sulphated bicarbonated saline water, sulphuretted. Its therapeutic properties, indications and uses are very similar to the Sulphur Spring.

The waters from these springs are highly radio-active, which we know today adds great therapeutic potency to its action on the human economy. The red men of the forest knew of and appreciated the "medicine water" at Passo Robles centuries before the coming of the white man. In the early days the Padres and their Franciscan superiors discovered the springs walled in with logs by the Indians, that they might bathe in the healing hot sulphur water. The Franciscan monks built a mission nearby, and the monks and other clergy came regularly a hundred years ago to spend a few weeks at the "healing waters" for the restoration of their health.

### Richardson Mineral Springs.

(*Bute County.*)

*Postoffice,* Richardson Springs, via Chico. *Location,* in the mountains of upper California; north of Chico, 12 miles; north of Sacramento, 100 miles; northeast of San Francisco, 180 miles; west of Carson City, 100 miles. *Situation,* at the foothills of the western slope of the Sierra Nevadas, amid a sylvian setting surrounded by spreading oaks. The springs issue from the earth 1000 feet above sea level. *Access,* via Chico Station, Sacramento Northern Railway and Southern Pacific Railway, thence 12 miles by the hotel's large motor bus, which meets all trains. *Hotel,* a new 200-room first-class hostelry, of brick, stone and concrete construction, with all modern conveniences, has just been opened. The Richardson Springs bathhouse is a new and up-to-date establishment, equipped with every known appliance for the most scientific administration of hot mineral baths; separate sections are provided for ladies and gentlemen, with competent masseurs and masseuses in attendance. There are a number of springs on the property, and we give herewith the analyses of the most important. The Richardson Mineral Springs have been found to be charged with radio-active properties and the radium emanations imparted to the waters greatly increases their therapeutic potency.

No. 1 Spring, medicinal classification, weak alkaline b4, strong saline 1.6, sulphate or (−Ab, +Cl 1.6, S). A study of the analysis shows this spring to be a very highly mineralized, sodic, potassic, muriated, saline water, carbon-dioxated, possessing diuretic, antacid and purgative properties. This water has been used with success in the treatment of rheumatism, catarrhal affections of the gastro-intestinal tract and in diseases of the liver.

RICHARDSON MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, not given). | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 1. | Montgomery. | Iron. | Beauty. | Radium. | Bath. |
| Ammonium chloride ($NH_4Cl$) | trace | none | none | none | none | none |
| Lithium chloride ($LiCl$) | trace | trace | none | none | none | none |
| Sodium chloride ($NaCl$) | 13,111.3 | 27.00 | 122.9 | 14,623.00 | 11,192.2 | 11,190.50 |
| Potassium chloride ($KCl$) | 2,905.0 | 34.60 | 327.8 | 2.50 | 637.0 | 2,614.90 |
| Sodium sulphate ($Na_2SO_4$) | 1,783.8 | 144.80 | 56.8 | 1,854.40 | 2,817.3 | 2,584.40 |
| Potassium sulphate ($K_2SO_4$) | none | none | 121.1 | none | none | none |
| Magnesium sulphate ($MgSO_4$) | 127.10 | 134.40 | 185.4 | 52.6 | 212.9 | 113.20 |
| Calcium sulphate ($CaSO_4$) | none | none | 143.5 | 732.40 | 410.7 | 1,263.80 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 44.5 | 18.00 | 214.9 | none | none | none |
| Ferrous sulphate ($FeSO_4$) | none | none | none | trace | none | none |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1,703.1 | 228.75 | 410.6 | 1,078.11 | 1,101.6 | 663.88 |
| Sodium bicarbonate ($NaHCO_3$) | none | none | 121.1 | none | none | none |
| Ferric oxide ($Fe_2O_3$) | trace | trace | 12.7 | none | none | none |
| Aluminum oxide ($Al_2O_3$) | none | none | none | trace | trace | 101.00 |
| Organic matter | trace | none | none | trace | trace | none |
| Total solids | 19,674.8 | 587.55 | 1716.8 | 18,343.01 | 16,371.7 | 18,624.68 |
| Gases: | | | | | | |
| Hydrogen sulphide, large quantities, cc. per liter | ... | ... | ... | 166 | 67.4 | 274.4 |

Montgomery Spring, medicinal classification, weak mineralized 2 or (−T2). This is a moderately mineralized, calcic, bicarbonated, sodic and magnesic sulphated alkaline-saline water, possessing antacid and diuretic properties, and has been successfully administered in the treatment of diseases of the genito-urinary tract and in gastric affections due to hyperacidity.

The Iron Spring is a moderately highly mineralized, calcic, sodic, potassic, magnesic sulphated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, tonic and alterative properties, and is valuable in the treatment of all depraved conditions of the blood and blood-making organs, general debility and wherever an iron tonic is indicated.

Beauty Spring, medicinal classification, weak alkaline b3, strong saline 1.5, sulphate or (−Ab3, +Cl 1.5, S), sulphuretted. This is a very highly mineralized, sodic, muriated, sulphated saline water, sulphuretted, and quite similar in its predominating chemical constituents, therapeutic properties and uses to Spring No. 1.

Radium Spring, medicinal classification, weak alkaline b3, strong saline 1.2, sulphate 2 or (−Ab3, +Cl 1.2, S2), sulphuretted. This is a highly mineralized, sodic, calcic, muriated, sulphated, saline water, sulphuretted, possessing diuretic and laxative properties, and has been used with success in the treatment of rheumatic disorders, skin affections and for the reduction of hypotension.

Bath Spring, medicinal classification, strong saline 1.4, sulphated 2 or (+Cl 1.4, S2), sulphuretted. This is a highly mineralized, sodic, calcic, muriated and sulphated saline water, sulphuretted, and used largely in the bathing establishment for various baths. The

water is heated with steam and conveyed through pipes to the bath-house, which is equipped with modern appliances for the practice of the latest knowledge in the science of hydrotherapy and balneology, administered under the direct supervision of a competent physician and a corps of trained assistants.

The waters are bottled and shipped extensively throughout California and adjoining states.

## Santa Ysabel Sulphur Springs.

*(San Luis Obispo County.)*

*Postoffice,* Passo Robles. *Location,* in southwestern California; southeast of San Francisco, 175 miles; northwest of Los Angeles, 180 miles. *Situation,* in a small canyon about 1 mile east of the Salinas River and in the valley of the same name, at an elevation of 775 feet above sea level. *Access,* via the Southern Pacific Railway to Passo Robles, thence $2\frac{1}{2}$ miles by motor to the springs. *Hotel,* there is a good hotel with some conveniences and a number of comfortable cottages offering accommodations for guests. The springs on analyses reveal the following mineralization:

SANTA YSABEL SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Winslow Anderson). | | | |
|---|---|---|---|---|
| | Main Warm Sulphur Spring. | Cold Sulphur. | | Warm Sulphur Mud Spring. |
| | | Spring No. 1. | Spring No. 2. | |
| Potassium chloride (KCl) | trace | trace | trace | trace |
| Sodium chloride (NaCl) | 309.51 | 196.13 | 196.65 | 292.41 |
| Potassium bromide (KBr) | trace | trace | trace | trace |
| Potassium iodide (KI) | trace | trace | trace | trace |
| Sodium iodide (NaI) | trace | trace | trace | trace |
| Sodium sulphate ($Na_2SO_4$) | 123.92 | 88.41 | 88.69 | 123.97 |
| Magnesium sulphate ($MgSO_4$) | 82.93 | 39.25 | 68.40 | 67.37 |
| Calcium sulphate ($CaSO_4$) | 39.67 | 49.50 | 50.44 | 40.18 |
| Sodium borate ($N_2B_4O_7$) | trace | trace | trace | trace |
| Potassium bicarbonate ($KHCO_3$) | 21.37 | ... | ... | 11.81 |
| Sodium bicarbonate ($NaHCO_3$) | 688.00 | 346.55 | 362.62 | 659.95 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 170.64 | 205.27 | 204.16 | 152.25 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 67.86 | 30.19 | 29.36 | 57.86 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 3.60 | 9.11 | 9.69 | 9.97 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 27.18 | 6.92 | 7.20 | 17.45 |
| Aluminum oxide ($Al_2O_3$) | 12.48 | 14.19 | 14.36 | 11.11 |
| Silica ($SiO_2$) | 27.62 | 20.00 | 20.52 | 108.40 |
| Total solids | 1566.78 | 1005.52 | 1052.09 | 1552.73 |
| Temperature, °C. | 34.4 | 14.4 | 14.8 | 35.2 |
| Gases: | | | | |
| Carbon dioxide, cc. per liter | 40.5 | 39.3 | 38.9 | 24.5 |
| Hydrogen sulphide, cc. per liter | 16.5 | 11.2 | 11.5 | 16.2 |

Main and Warm Mud Springs, medicinal classification, weak alkaline ab2, weak total 4 or (−Aab2, −T4), thermic, sulphuretted. The analysis of these springs shows that the amount of total solids and the percentage of the predominating chemical constituents are so nearly alike that the water may be classified as moderately highly mineralized, thermic, sodic, muriated and sulphated, bicarbonated alkaline-saline (ferruginous) waters, sulphuretted, possessing diuretic, antacid, aperient, tonic and sedative properties, and have been found useful in the treatment of a wide range of diseases of the stomach, bowels, liver and kidney.

Cold Sulphur Spring, No. 1, medicinal classification, weak alkaline ab, weak total 2 or (−Aab, −T2), sulphuretted.

Cold Sulphur Spring, No. 2, medicinal classification, weak alkaline ab, weak total 3 or (−Aab, −T3), sulphuretted.

The Cold Sulphur Springs, Nos. 1 and 2, are also so similar in amount of total solids and in the percentage of their predominating chemical constituents that we will class them as a moderately mineralized, sodic, muriated and sulphated bicarbonated alkaline-saline (slight ferruginous) water, sulphuretted, possessing diuretic, antacid, aperient, tonic and sedative properties. These waters have attained a reputation in gastro-intestinal disorders and in affections of the renal and vesical organs, chronic and rheumatic affections and skin diseases.

### Saratoga Mineral Springs.

(*Lake County.*)

*Postoffice*, Bachelor. *Location*, in the western portion of the state; north of San Francisco, 100 miles; northwest of Sacramento, the capital city, 80 miles; east of Ukiah, 21 miles; northeast of Lakeport, 14 miles. *Situation*, nestled atop a charming plateau, 1500 feet elevation above sea level. *Access*, via Ukiah, on the Northern Pacific Railway, thence by motor, over graded macadam highways, through a beautiful picturesque mountainous region, 12 miles to the springs. *Hotel*, the hotel is a commodious resort hostelry, with ample conveniences. There is a modern bath-house connected with the hotel for the scientific administration of hot mineral baths, and there is also a large outdoor natatorium for those who enjoy swimming. There are 12 springs in the area, all within a short distance of the hotel. Six of the springs arise within a few feet of each other, and all under one roofed spring house. The analyses of the 4 most important of this group are given below. Ten yards southwestward from this group are 2 similar springs, and 20 yards to the west is the Magnesia Spring, which is noticeably less carbonated, but more highly ferruginous. Fifty yards south of the group of 6 is a highly carbonated iron spring. About 75 yards north of the Six Group Springs is a sulphur spring, emitting sulphuretted hydrogen. There is another spring seeping

from massive sandstone $\frac{2}{5}$ mile up the ravine from the hotel. Iron-stained lime carbonate is deposited from its waters on the stone surrounding the spring, which indicates a similar chemical composition to the springs of the main group.

SARATOGA MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Gerald A. Warring, U. S. Geological Survey). | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Potassium chloride (KCl) | 9.7 | 8.2 | 5.7 | 6.3 |
| Sodium chloride (NaCl) | 83.1 | 71.1 | 41.7 | 21.4 |
| Sodium sulphate ($Na_2SO_4$) | trace | trace | 6.1 | 7.8 |
| Sodium bicarbonate ($NaHCO_3$) | 537.5 | 310.2 | 338.0 | 252.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2760.0 | 2536.0 | 1750.0 | 1082.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1091.0 | 874.0 | 595.0 | 473.0 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 81.5 | 16.2 | 11.5 | 11.5 |
| Aluminum oxide ($Al_2O_3$) | 5.1 | 5.3 | 3.8 | 3.0 |
| Silica ($SiO_2$) | 105.0 | 101.0 | 93.0 | 84.0 |
| Total solids | 4609.9 | 3922.0 | 2844.8 | 1941.0 |

Springs Nos. 1 and 2, medicinal classification, alkaline b2 or (Ab2).

Springs Nos. 3 and 4, medicinal classification, alkaline b or (Ab).

A careful examination of the analyses of the 4 springs above shows that the predominating chemical constituents are quite similar in percentage and may be classed as moderately highly mineralized, magnesic, calcic, sodic, bicarbonated alkaline (ferruginous) waters, carbon-dioxated, possessing diuretic, antacid and tonic properties. The waters have been used with success in the treatment of digestive disturbances due to acidity, and have given relief in irritation of the genito-urinary tract. Owing to the high magnesia content, the waters exert a mild and efficient laxative action, and are of value in the treatment of constipation. The high bicarbonate content of these waters render them a pleasing antacid, especially in digestive disturbances, fulness after meals, water brash and all dyspeptic conditions.

## Veronica Springs.

(*Santa Barbara County.*)

*Postoffice,* Santa Barbara. *Location,* in the extreme southwestern portion of the state; northwest of Los Angeles, 100 miles; southwest of San Francisco, about 250 miles. *Situation,* at the foot of the Montecito Hills, which reach back from the coast to the San Marcus Mountains, east of Santa Barbara. The springs, 7 in number, crop out along the south slope of the hills, overlooking Santa Barbara Bay and

Santa Barbara Islands. *Access*, via the Southern Pacific Railway and by motor over the splendid national highways passing through semi-tropical lower California. The scenic beauty of this region is marvelous, grand and impressive. *Hotels*, no accommodation for guests, but daily throngs of visitors come to the springs from all parts of the United States. Plans to build a large hotel and bathing establishment are under consideration. The analysis of the Veronica water discloses the following mineralization (Analysis No. 1 is furnished by the springs and No. 2 is taken from *Bulletin* No. 91, Bureau of Chemistry, Department of Agriculture, Washington, D. C.):

VERONICA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. Owners' analysis, No. 1. | Analysis No. 2. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | ... | 0.24 |
| Potassium chloride (KCl) | ... | 169.50 |
| Sodium chloride (NaCl) | 3,037.58 | 3,170.00 |
| Magnesium chloride ($MgCl_2$) | 701.87 | |
| Potassium iodide (KI) | ... | trace |
| Sodium sulphate ($Na_2SO_4$) | 4,479.02 | 802.70 |
| Magnesium sulphate ($MgSO_4$) | 15,505.10 | 14,151.40 |
| Calcium sulphate ($CaSO_4$) | 892.59 | 744.30 |
| Magnesium nitrate ($MgNO_3$) | 5,299.19 | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | ... | trace |
| Sodium nitrate ($NaNO_3$) | ... | 2,384.90 |
| Potassium bicarbonate ($KHCO_3$) | 204.83 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1,894.36 | 1,397.80 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 4.00 | 3.70 |
| Silica ($SiO_2$) | 18.10 | 18.10 |
| Total solids | 32,036.64 | 22,842.64 |

Analysis No. 2, medicinal classification, strong sulphate 1.6, strong total 2.3 or (+S1.6, +T2.3). This is a highly mineralized, sodic, magnesic, sulphated and muriated, saline water, possessing diuretic and purgative properties, due to the magnesium and sodium sulphates; the ingestion of this water stimulates intestinal peristalsis, increases the flow of bile, dissolves and liquefies the mucus of the intestinal tract and biliary passages. This water has been prescribed by the profession for more than twenty-five years for the relief of constipation and general sluggishness of bowel action. It is also of value in chronic dyspepsia, with insufficiency of the digestive fluids. Its action neutralizes acidity, augments bowel action and aids in the elimination of alimentary concretions, scylabæ. The waters are bottled just as they come from Nature's laboratory, without "fortification" and are sold throughout the United States and even shipped to foreign countries.

## Warner's Hot Springs.

(*San Diego County.*)

*Postoffice*, Warner's Hot Springs. *Location*, in southeastern California; north of the Mexican boundary line, 45 miles; north of San

Diego on the Pacific Coast, 68 miles; southeast of Los Angeles, 134 miles. *Situation*, on the eastern side of Warner Valley, at the base of Hot Springs Mountain at an elevation of 3165 feet above sea level, while the pinnacle of this mountain is 6500 feet in altitude. The climatic conditions are delightful at all seasons. *Access*, via San Diego on the Atchison, Topeka & Santa Fe Railway, thence a distance of 68 miles by motor to the springs, or via motor car over the great national highways which traverse this section—the delight of motorists. *Hotel*, there are ample accommodations. The bathing establishment is modern in construction and equipment for administering these natural hot sulphur baths, expert masseurs and masseuses in attendance. The spring issues from a fault in a ravine surrounded by granite rocks which extends along the east side of Warner Valley; warm springs of small flow issue at several points, which suggest seepage from the deeper sources. This place was long known to the Mexicans as Las Aguas Calientes (the hot waters). The analysis below shows the mineralization.

WARNER'S HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Curtis & Tomkins). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 1.54 |
| Lithium chloride ($LiCl$) | trace |
| Sodium chloride ($NaCl$) | 40.96 |
| Potassium sulphate ($K_2SO_4$) | 7.36 |
| Sodium sulphate ($Na_2SO_4$) | 96.30 |
| Magnesium sulphate ($MgSO_4$) | 1.53 |
| Sodium biborate ($Na_2B_4O_7$) | 1.53 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 1.88 |
| Sodium bicarbonate ($NaHCO_3$) | 72.91 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace |
| Manganese oxide ($MnO_2$) | trace |
| Ferric oxide ($Fe_2O_3$) | 0.68 |
| Sodium silicate ($Na_2SiO_3$) | 45.16 |
| Calcium silicate ($CaSiO_3$) | 6.50 |
| Sodium sulphide ($Na_2S$) | 91.19 |
| Silica ($SiO_2$) | 58.86 |
| Total solids | 426.40 |
| Temperature, °C. | 64.4 |
| Gases: | |
| Sulphuretted hydrogen, cc. per liter | 3.4 |
| Flow in gallons per day, exceeding | 200,000 |

Medicinal classification, weak total mineralization or (−T), thermic, sulphuretted. A careful study of the analysis shows a moderately mineralized, thermic, sodic, muriated, sulphated and bicarbonated saline (phosphatic) water, sulphuretted, and possessing slight antacid, diuretic, tonic and alterative properties, and of use in a wide range of diseased conditions. Its mild alkalinity makes it an admirable antacid in digestive disturbances due to acidity and hyperacidity; its sulphate ions stimulate intestinal activity, producing laxative action. It exerts a pleasing action on catarrhal disorders of the liver and bile

ducts. The chronic irritations of the genito-urinary yield to its mild therapeutic properties. Its tonic and alterative properties indicate its use in anemia, chlorosis and leukocythemia, neurasthenia, etc., and as a general tonic in all depraved conditions of the circulating fluid, especially where the coloring matter of the hemoglobin is below normal. The hot sulphur baths are useful in the treatment of chronic rheumatism, rheumatic arthritis, neuritis and in all chronic states of the integumentary system.

### Wilbur Hot Sulphur Springs.

*(Colusa County.)*

*Postoffice*, Wilbur Springs. *Location*, west of the Sacramento River Valley; northwest of Sacramento, 60 miles; southwest of Williams, 25 miles; north of San Francisco, 100 miles; 30 miles from Colusa. *Situation*, on the eastern slope of the Coast Range of mountains, at an elevation of 1400 feet above sea level. *Access*, via the Southern Pacific Railway to Williams, thence by motor over good graded highways, through a beautiful, but rugged mountainous country, a distance of 25 miles to the springs. *Hotel*, there is a commodious hostelry, with modern conveniences. The resort is open all year round. The bathing establishment is equipped for the administration of all kinds of sulphur and mud baths. The waters are naturally heated and have acquired quite a reputation for the relief of rheumatic conditions, sciatica and neuritis. There are a number of springs, and we present herewith the analyses of only 4:

WILBUR HOT SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. W. H. Sloan). | | | |
|---|---|---|---|---|
| | Spring No. 10. | Spring No. 14. | Spring No. 20. | Spring No. 22. |
| Ammonium chloride ($NH_4Cl$) | 363.238 | 486.324 | 799.989 | 869.257 |
| Lithium chloride (LiCl) | 41.587 | 68.457 | 62.158 | 79.315 |
| Potassium chloride (KCl) | 358.723 | 859.326 | 714.489 | 766.062 |
| Sodium chloride (NaCl) | 8428.077 | 15,408.126 | 14,004.045 | 14,386.401 |
| Potassium iodide (KI) | 13.030 | 22.888 | 23.922 | 19.682 |
| Potassium bromide (KBr) | 3.950 | 20.287 | 23.922 | 19.682 |
| Sodium sulphate ($Na_2SO_4$) | 45.776 | 340.632 | 235.315 | 253.942 |
| Sodium nitrate ($NaNO_3$) | 148.154 | 402.619 | trace | trace |
| Sodium metaborate ($NaBO_2$) | 574.235 | 1137.834 | 1037.268 | 980.685 |
| Sodium bicarbonate ($NaHCO_3$) | 4644.189 | 8063.074 | 8516.655 | 8649.457 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 395.010 | 372.660 | 42.066 | 317.478 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | ... | 14.398 | ... | 31.156 |
| Magnesium silicate ($MgSiO_3$) | ... | ... | 183.157 | |
| Iron and alumina oxide ($FeO_3$, $Al_2O_3$) | 2.787 | 4.993 | 2.086 | 3.249 |
| Calcium silicate ($CaSiO_3$) | 11.337 | ... | 2.039 | |
| Silica ($SiO_2$) | ... | 64.826 | 6.840 | 174.710 |
| Total solids | 15,030.293 | 27,252.046 | 25,853.851 | 27,519.920 |
| Temperature, °C. | 48.9 | 21.1 | 46.7 | 60 |

Hot Black Sulphur Spring, No. 10, medicinal classification, alkaline a3, strong saline (iodic) or (Aa3, +Cl(I)), thermic. This spring has a temperature of 48.9° C. (120° F.), and is a highly mineralized, sodic, muriated and bicarbonated alkaline-saline (iodic, bromic) water, carbon-dioxated and sulphuretted.

Rainbow Spring, No. 14, medicinal classification, strong alkaline a(B), strong saline 2 (iodic) or (+Aa(B), +Cl 2(I)). This spring has a temperature of 21.1° C. (70° F.), and is a very highly mineralized, sodic, muriated and bicarbonated alkaline-saline (iodic) water, carbon-dioxated and sulphuretted.

Spring No. 20, medicinal classification, strong alkaline a(B), strong saline 2 (iodic) or (+Aa(B), +Cl 2(I)), thermic. This is catarrh and complexion water, with a temperature of 46.7° C. (116° F.), and is a highly mineralized, thermic, sodic, muriated and bicarbonated alkaline-saline (iodic, bromic) water, carbon-dioxated and sulphuretted.

Spring No. 22, medicinal classification, strong alkaline a(B), strong saline 2 (iodic) or (+Aa(B), +Cl 2(I), thermic. This is of hot sulphur water, with a temperature of 60° C. (140° F.), and flowing at the rate of 30,000 gallons daily; it is a very highly mineralized, thermic, sodic, muriated and bicarbonated alkaline-saline (iodic, bromic) water, carbon-dioxated and sulphuretted.

It will be observed from closely examining the analyses that the predominating chemical constituents are quite similar in all of the waters. They are all strongly sulphuretted, and for many years have been largely used in the treatment of rheumatic and arthritic conditions of the joints. They have some reputation in catarrhal conditions of the alimentary tract and in disorders of the liver and gall ducts.

There are 4 other springs: Spring No. 24 is a cold magnesia water, with total solids of 1515.707 parts per 1,000,000; Spring No. 28 is a cold white sulphur water, with total solids of 2,780.750 parts per 1,000,000; Spring No. 30 is a cold black sulphur water, with total solids of 1967.826 parts per 1,000,000; Spring No. 34, Jackson Spring, is a cold water, with total solids of 1443.188 parts per 1,000,000. The whole 8 springs are valuable medicinal waters; the 4 latter are moderately mineralized and the former are highly mineralized.

The following springs were once used as resorts:

*Aguas Caliente, P. O.*, Sonoma, Sonoma County. At one time this spring was quite celebrated, but could not reach the owners; correspondence returned by postmaster marked unknown.

*Agua de Vida Springs, P. O.*, Livermore, in Arroya Rancho. Once a popular resort, but no satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Allen's Springs, P. O.*, Bartlett Springs, Lake County. Once a popular resort, but definite information unavailable; correspondence unanswered.

*Alum Rock Springs, P. O.*, San Jose, Santa Clara County. There are several springs in this area, but no definite information nor satisfactory analysis available; correspondence unanswered.

*Blodgett's Springs, P. O.*, Gilroy, Santa Clara County. Not open to the public so the owner writes, and does not furnish a satisfactory analysis.

*Bonanza Hot Springs, P. O.*, Seiglers, Lake County. Several springs in this area, but no satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*California Seltzer Springs, P. O.*, Cloverdale, Mendocino County. Developed as a resort, 13 springs, but allowed to decline. Postmaster returns letters marked "unknown."

*Coronado Spring, P. O.*, Coronado Beach, San Diego County. Once a popular resort; the Coronado Hotel was once one of the finest caravansaries in the world, but must have passed into decline. Postmaster returns correspondence marked "unknown."

*Eureka Springs, P. O.*, Eureka, Humbolt County. No satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Gilroy Hot Springs, P. O.*, Gilroy Springs, Santa Clara County. No information nor satisfactory analysis available; correspondence unanswered.

*Gordon Springs, P. O.*, Calistoga, Lake County. No information nor satisfactory analysis available; correspondence ignored.

*Hot Barate Springs, P. O.*, Lakeport, Lake County. No information nor satisfactory analysis available; correspondence ignored.

*Hough's Mineral Springs, P. O.*, Williams, Lake County. No definite information nor satisfactory analysis available; correspondence unanswered.

*Cornelian Hot Springs, P. O.*, Lake Tahoe, Placer County. A popular resort, but no satisfactory analysis available. The appointments at the spring are very complete; an excellent bathing establishment, hot and cold sulphur baths. The springs are about 50 in number, many of them well improved and cared for.

*Owens' Lake, P. O.*, Owens' Lake, Inyo County. A "dead sea," embracing 100 square miles, rich in saline and alkaline salts. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Piedmont White Sulphur Springs, P. O.*, Oakland, Alameda County. Once a popular resort, with well-kept hotel commanding a picturesque view of San Francisco Bay. Resorted to by residents of San Francisco and Oakland. No definite information nor satisfactory analysis available.

*Santa Barbara Hot Sulphur Springs, P. O.*, Santa Barbara, Santa Barbara County. There are some 20 springs in this area, but no definite information nor satisfactory analysis available. Correspondence returned by postmaster marked "unknown."

*Santa Rosa White Sulphur Springs, P. O.*, Santa Rosa, Sonoma County. Once a popular resort, but no definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Seigler's Springs, P. O.*, Bonanza Springs, Lake County. No information nor satisfactory analysis available; correspondence unanswered.

*Skagg's Hot Springs, P. O.*, Sonoma County. No definite information nor satisfactory analysis available; correspondence unanswered.

*Summit Soda Springs, P. O.*, Placer County. In the summit of the Sierre Nevada Mountains. No definite information nor satisfactory analysis available; correspondence ignored.

*Thermal Acid Springs, P. O.*, Olamoha, Inyo County. This is a remarkable acid spring heavily charged with aluminum sulphate and sulphuric acid (free). No definite information, nor satisfactory analysis available; correspondence unanswered.

*Tolenas Springs, P. O.*, Suisun, Solano County. There are 19 springs in this area. This was once a very popular resort, but no definite information nor satisfactory analysis available; correspondence uanswered.

*Tuscan Springs, P. O.*, Red Bluff, Tehoma County. It is said to be similar in its medicinal properties to the Blue Lick Springs in Kentucky, but no definite information nor satisfactory analysis is available; correspondence unanswered.

*Upper Soda Springs, P. O.*, Dunsmuir, Siskiya County. In Sacramento Canyon, whose walls are almost perpendicular. No definite information nor satisfactory analysis available; correspondence unanswered.

*Volcanic Mineral Springs, P. O.*, Volcanic Station. In Death Valley. No definite information nor satisfactory analysis available; correspondence unanswered.

*Zem Zem Springs, P. O.*, Clear Lake, Lake County. No definite information nor satisfactory analysis available. Postmaster advises "unknown."

The following springs reported the sale of water during the year 1924:

*Albion Spring, P. O.*, San Francisco, San Francisco County.
*Alhambra Springs, P. O.*, Martinez, Contra Costa County.
*Alma Spring, P. O.*, Alma, Santa Clara County.
*Barcal Mineral Spring, P. O.*, Preston, Sonoma County.
*Beulah Springs, P. O.*, Arlington, Riverside County.
*Bimini Hot Springs, P. O.*, Los Angeles, Los Angeles County.
*Crystal Springs, P. O.*, Los Angeles, Los Angeles County.
*El Granito Mineral Springs, P. O.*, El Cajon, San Diego County.
*Elysian Springs, P. O.*, Los Angeles, Los Angeles County.
*Grizzly Springs, P. O.*, Williams, Lake County.
*Holly Springs, P. O.*, Hollywood, Los Angeles County.
*Iaqua Medicinal Springs, P. O.*, Eureka, Humboldt County.
*Lepori Vichy Springs, P. O.*, Napa, Napa County.

*Melrose Mineral Spring, P. O.*, Los Angeles, Los Angeles County.
*Monterey Mineral Well, P. O.*, Monterey, Monterey County.
*Mount San Miguel Mineral Spring, P. O.*, National City, San Diego County.
*Napa Rock Spring, P. O.*, St. Helena, Napa County.
*Norman Medical Springs, P. O.*, Middletown, Lake County.
*Polk Springs, P. O.*, Butte Meadows, Tehama County.
*Rock Springs, P. O.*, Escondido, San Diego County.
*Shanghai Spring, P. O.*, Sausalito, Marin County.
*Shasta Springs, P. O.*, Shasta Springs, Siskiyou County.
*Tamalpais Spring, P. O.*, San Rafael, Marin County.
*Valley Springs, P. O.*, Valley Springs, Calaveras County.
*Vichy Springs, P. O.*, Ukiah, Mendocino County.
*Walter's Springs, P. O.*, St. Helena, Napa County.
*White Rose Spring, P. O.*, Los Angeles, Los Angeles County.

## COLORADO.

Colorado extends from 37° to 41.5° north latitude and from 120° to 109° west longitude, and comprises an area of 104,500 square miles, and is the third largest state in the Union, ranking after Texas and California. The main range of the great Rocky Mountains runs through the center of the state and forms the Continental Divide. Streams rising on the eastern slope of the divide empty through the Mississippi into the Gulf of Mexico, and those on the western slope find their way into the Pacific Ocean. Some of the mountainous peaks in this region attain an enormous elevation, and in their giddy heights, yawning chasms, terrific canyons and perpendicular gulches are to be found some of the grandest and most awe-inspiring scenery in the world. The mean annual temperature is about 8.9° C. (48° F.). The climate is proverbially salubrious, the atmosphere being dry and bracing and generally free from malaria and other miasmatic poisons.

Colorado has 70 spring localities, with a total of 359 individual springs, 37 of which have been analyzed. Both hot and cold mineral springs abound in Colorado and contribute to the state as a health resort. Some of these, though known of only a few years, have acquired a wide reputation. Among the most prominent are the Glenwood Hot Springs and the Manitou Springs, at the base of Pike's Peak. The authorities for the list herewith are from the geological reports, from Peale's lists and from Crook's work and principally from the work of R. D. George, State Geologist (*Bull.* No. 11, Mineral Waters of Colorado).

### Boulder Radium Springs.

(*Boulder County.*)

*Postoffice*, Boulder. *Location*, northeast of central Colorado; north of Denver, the capital city, 20 miles; west of Boulder, the county seat,

80 miles. *Situation*, on James Creek Canyon, in the heart of the Rocky Mountains, at an elevation of about 11,500 feet above sea level. *Access*, via Boulder, on the Chicago, Burlington & Quincy Railway System and connections, thence a distance of 8 miles by motor to the springs, and via automobile (good roads) from Boulder. *Hotels*, this has always been a very popular resort. Pavilions, cabins and bath-houses, with modern accommodations for visitors and guests. There are 4 springs, of which we append analyses below:

BOULDER RADIUM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | |
|---|---|---|---|---|
| | Curie Spring. | Cave Spring. | Bath Spring. | Arapahoe Spring. |
| Potassium chloride (KCl) | 124.5 | 115.0 | 151.3 | 67.3 |
| Sodium chloride (NaCl) | 43.4 | 56.1 | 44.7 | 66.6 |
| Sodium sulphate ($Na_2SO_4$) | 1775.2 | 1972.1 | 1969.6 | 1636.3 |
| Magnesium sulphate ($MgSO_4$) | 188.6 | 203.9 | 210.4 | 165.3 |
| Calcium sulphate ($CaSO_4$) | 122.0 | 63.4 | 108.1 | 53.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1382.6 | 1553.1 | 1538.1 | 1282.1 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 8.9 | 8.9 | 20.0 | 15.6 |
| Calcium silicate ($CaSiO_3$) | 171.8 | 173.1 | 177.4 | 158.7 |
| Total solids | 3817.0 | 4145.5 | 4219.6 | 3445.2 |
| Temperature, °C. | 14.5 | 12.5 | 14.0 | 15.5 |
| Gases: | | | | |
| Carbon dioxide, excess | 422.5 | 351.9 | 377.5 | 423.8 |
| Radio-activity, Mache units per liter | 735.8 | 29.25 | 37.37 | 166.0 |
| Flow in gallons per day | 2500 | 1000 | 2400 | 2200 |

The Curie Spring, medicinal classification, weak alkaline b4, sulphate or (−Ab4, S), very strong radio-active 3. This is a moderately highly mineralized, sodic, bicarbonated, calcic, sulphated alkaline-saline water, carbon-dioxated, radio-activated, possessing diuretic, antacid, slight laxative tonic and alterative properties.

The Cave Spring, medicinal classification, weak alkaline b4, sulphate or (−Ab4, S), radio-active. This is a moderately highly mineralized, sodic, calcic magnesic sulphated and calcic bicarbonated alkaline-saline water, radio-activated, carbon-dioxated, possessing antacid, tonic, laxative and alterative properties.

The Bath Spring, medicinal classification, weak alkaline b4, sulphate or (−Ab4, S), radio-active. This is a moderately highly mineralized, sodic, magnesic, sulphated, bicarbonated, alkaline-saline water, carbon-dioxated, radio-activated, possessing antacid, diuretic and tonic and laxative properties.

The Arapahoe Spring, medicinal classification, weak alkaline b3, sulphate or (−Ab3, S), strong radio-active 3. This is a moderately highly mineralized, sodic, magnesic, sulphated and calcic bicarbonated

alkaline-saline water, carbon-dioxated, radio-activated, possessing antacid, diuretic, laxative, tonic and alterative properties.

These waters are indicated in the treatment of diseases of the stomach, bowels and liver. They are also valuable in the treatment of anemia and general debility. These waters contain from 8 to 20 mg. per liter of the bicarbonate iron, which is the most desirable form of this constituent for easy assimilation by most invalids who need an iron tonic. The waters are mildly aperient, effervescent and agreeable, suitable for many disorders characterized by anemia or associated with enfeebled digestion, and especially those debilitated constitutions so often found in women and young girls. The radium emanations are very high in these waters, and exert potent therapeutic effects.

## Canon City Hot Springs.

(*Fremont County.*)

*Postoffice*, Canon City. *Location*, south of central Colorado; south of Denver, the capital city, 90 miles; southwest of Colorado Springs, 40 miles. *Situation*, in the valley of the Arkansas River and on the south side of the river at the lower end of the Royal Gorge, at an elevation of about 8000 feet above sea level. *Access*, via the Missouri Pacific Railway, thence only a short distance to the springs. *Hotel*, there is a typical western resort hostelry with accommodations. There are a number of springs and wells in this area, as will be seen from the analyses below:

CANON CITY HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | |
|---|---|---|---|---|---|
| | Fremont Natatorium Spring. | Canon City Hot Spring. | Soda Spring. | Iron Duke Spring. | Grape Creek Spring. |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 74.35 | 63.31 | 354.70 | 152.6 | trace |
| Sodium chloride (NaCl) | ... | 253.90 | 1662.30 | 1480.8 | 2283.30 |
| Sodium sulphate ($Na_2SO_4$) | 531.20 | 165.50 | 253.60 | 247.4 | 260.90 |
| Potassium sulphate ($K_2SO_4$) | 90.72 | | | | |
| Magnesium sulphate ($MgSO_4$) | 219.70 | | | | |
| Sodium bicarbonate ($NaHCO_3$) | ... | 26.77 | 1403.95 | 1382.4 | 2691.4 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 125.34 | 322.40 | 289.60 | 326.7 | 1156.30 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 610.20 | 685.00 | 486.90 | 461.8 | 783.20 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | ... | ... | ... | 24.50 |
| Silica ($SiO_2$) | 42.60 | 26.10 | 23.80 | 22.3 | 91.90 |
| Total solids | 1694.11 | 1542.98 | 4474.85 | 4074.0 | 7290.70 |
| Gases: | | | | | |
| Excess carbon dioxide | 203.3 | 289.4 | 586.9 | 585.6 | 1271.11 |
| Hydrogen sulphide | trace | | | | |
| Temperature, °C. | 37.4 | 38.6 | 20 | 40 | 13.3 |

The Fremont Natatorium Well, medicinal classification, weak alkaline b2, weak sulphated 2 or (−Ab2, −S2), thermic. This well is situated 3 miles east of Canon City. The well is 1655 feet deep, and in all probability the water comes from the Dakota sandstone formation. This is a moderately highly mineralized, sodic, calcic, magnesic, bicarbonated, sulphated, alkaline-saline water, carbon-dioxated, possessing diuretic antacid, slight laxative and alterative properties.

The Canon City Hot Springs, medicinal classification, weak alkaline b3, weak total 4 or (−Ab3, −T4), thermic. This is a moderately highly mineralized, calcic, sodic, bicarbonated, muriated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid and alterative properties.

The Soda Spring, medicinal classification, alkaline-saline or (AaCl). This is a walled-up spring but free to the public. It no doubt arises from the Dakota formation. The carbonic acid gas arises in large amounts. This is a moderately highly mineralized, sodic, bicarbonated muriated, alkaline-saline water, carbon-dioxated, possessing diuretic antacid, slight laxative and alterative properties.

The Iron Duke Spring, medicinal classification, alkaline a, weak saline 4 or (Aa, −Cl 4), thermic. This is within a few feet of the Soda Spring and arises from the Dakota sandstone formation. It is a moderately highly mineralized, sodic, bicarbonated, muriated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid and slight laxative properties.

Grape Creek Spring, medicinal classification, alkaline ab2, saline or (Aab2, Cl). This is some little distance from Canon City. It issues from the creek bottom some 25 feet from the channel arising from the precambrian granite area. This is a highly mineralized, sodic, bicarbonated, muriated, alkaline-saline water, carbon-dioxated, possessing diuretic, light laxative, tonic and alterative properties.

### Clark's Magnetic Mineral Springs.

(*Pueblo County.*)

*Postoffice,* Pueblo. *Location,* southeast of central Colorado; south of Denver, the capital city, 100 miles; south of Colorado Springs; 40 miles; southeast of Greenwood Springs, 170 miles. *Situation,* in a rugged mountainous region, east of the Continental Divide, at an elevation of 4600 feet above sea level. *Access,* via the Chicago, Rock Island & Pacific Railways System. *Hotel,* Clark's Sanitarium is a large structure of three and a half stories of brick construction, fronting 160 feet on "B" Street, with all modern conveniences. Recently it became necessary to add a general hospital department, with operating room and the usual hospital equipment to take care of the patients needing this type of professional care. The bathing department is modern in construction and equipment, separate sections for men and

women. The balneotherapeutic department is equipped with the most approved appurtenances used in standard institutions of this class, and the service is rendered by experienced bath attendants. The analysis below shows the mineralization of several springs in this area.

CLARK'S MAGNETIC MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | |
|---|---|---|---|---|
| | Pueblo Lithia Spring. | Clark's Magnetic Mineral Spring. | Hospital Artesian Well. | Ferris Artesian Well. |
| Lithium chloride (LiCl) | trace | trace | trace | trace |
| Potassium chloride (KCl) | 44.24 | 41.38 | 49.96 | 2.23 |
| Sodium chloride (NaCl) | 16.32 | 13.78 | 2.11 | 63.80 |
| Sodium sulphate ($Na_2SO_4$) | 690.50 | 684.30 | 495.70 | 415.50 |
| Magnesium sulphate ($MgSO_4$) | 80.80 | 71.68 | ... | 169.25 |
| Calcium sulphate ($CaSO_4$) | ... | ... | ... | 301.50 |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 373.54 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 10.83 | 63.78 | 65.71 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 299.43 | 198.80 | 23.00 | 458.70 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 5.57 | 5.01 | | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | ... | ... | 2.60 | |
| Calcium silicate ($CaSiO_3$) | ... | ... | 21.42 | |
| Silica ($SiO_2$) | 12.40 | 17.40 | ... | 11.80 |
| Total solids | 1159.37 | 1096.13 | 1034.04 | 1430.48 |
| Gases: | | | | |
| Carbon dioxide, excess, cc. per liter | 185.92 | 74.36 | 123.80 | 126.4 |
| Radio-activity, Mache units per liter | ... | 2.70 | 0.55 | trace |

Pueblo Lithia Spring, medicinal classification, weak sulphated 2, weak total 3 or (−S2, −T3) carbon-dioxated. This is a moderately mineralized, sodic, sulphated saline water, carbon-dioxated and radio-activated, possessing antacid, diuretic, laxative and tonic properties.

Clark's Magnetic Mineral Spring, medicinal classification, weak sulphated 2, weak total 3 or (−S2, −T3), weak radio-activated, carbon-dioxated. This is a moderately mineralized, sodic, sulphated, ferric, calcic, bicarbonated saline water, carbon-dioxated and radio-activated, possessing diuretic, antacid and tonic properties. This water is highly endorsed in the disintegration of vesical and renal calculi, the solvent action of the water exerting a happy solvent action on this type of concretions. Rheumatism and chronic joint disturbances, sciatica and neuritis yield to its therapeutic potency; chronic hepatic disorders, constipation, etc., are relieved through the action of the sulphate ions in solution in the water.

Hospital Artesian Well, medicinal classification, weak alkaline a, weak sulphated, weak total 3 (−Aa, −S, −T3) carbon-dioxated. This is a moderately mineralized, sodic, bicarbonated, sulphated

alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, purgative and tonic properties.

The Ferris Artesian Well, medicinal classification, weak alkaline b, weak sulphated 2, weak total 4 or (−Ab, −S2, −T4) carbon-dioxated. This is a moderately mineralized, sodic, calcic, magnesic, sulphated saline water, carbon-dioxated, possessing diuretic, antacid, slight laxative and tonic properties. Clark's (radium) magnetic mineral water is bottled and shipped extensively throughout this and adjoining states.

### Crested Butte Springs.

*(Gunnison County.)*

*Postoffice*, Crested Butte. *Location*, southwest of central Colorado; southwest of Denver, the capital city, 120 miles; west of Colorado Springs, 115 miles; southeast of Glenwood Springs, 80 miles. *Situation*, in the great Rocky Mountains region, on a branch of Taylor River, at an elevation of about 8000 feet above sea level, surrounded by a rugged mountainous region clothed with pine, fir and spruce. *Access*, via the main line of the Denver & Rio Grande Railway. *Hotel*, good accommodations at Crested Butte, with every convenience. The springs in this area show the following mineralization:

CRESTED BUTTE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | |
|---|---|---|---|---|---|
| | Ranger Spring. | Park Spring. | Jarvis Spring. | | Iron Spring. |
| | | | No. 1. | No. 2. | |
| Potassium chloride (KCl) | 50.3 | 15.3 | trace | 7.1 | trace |
| Sodium chloride (NaCl) | ... | 10.6 | 1..2 | ... | 8.4 |
| Sodium sulphate ($Na_2SO_4$) | 139.3 | 79.7 | 109.9 | 63.6 | 9.0 |
| Magnesium sulphate ($MgSO_4$) | ... | 32.8 | 152.8 | ... | 14.8 |
| Potassium sulphate ($K_2SO_4$) | 13.6 | ... | ... | 12.9 | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | ... | 1.5 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 146.2 | 96.8 | 83.6 | 108.0 | 1.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 302.9 | 226.5 | 442.8 | 188.4 | 21.8 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | ... | ... | 7.8 | 11.1 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | ... | ... | 5.5 | ... | 5.7 |
| Calcium silicate ($CaSiO_3$) | ... | 67.2 | 34.0 | | |
| Silica ($SiO_2$) | 27.7 | ... | ... | 22.7 | 14.7 |
| Total solids | 688.7 | 529.0 | 839.8 | 412.0 | 86.7 |
| Temperature, °C. | 28.5 | 24.4 | 6.7 | 6.7 | 13.3 |
| Gases: | | | | | |
| Carbon dioxide cc. per liter | 126.2 | 54.6 | 145.3 | 85.9 | 9.0 |

Ranger's Spring, medicinal classification, weak alkaline b, weak total 2 or (−Ab, −T2) carbon-dioxated. This spring is situated on forest

range 1½ miles above the mouth of Cement Creek. The water issues from the sedimentary rocks and a large mound of travertine is thrown up around the spring. This is a moderately mineralized, thermic, calcic, bicarbonated, sodic, sulphated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid and alterative properties.

Park Spring, medicinal classification, weak total or (−T). This spring is situated in the park about 3 miles above the mouth of Cement Creek; a body of pre-Cambrian granite lies between this spring and Ranger's Spring, but the waters issue from limestone and have deposited considerable calc and sinter. This is a moderately mineralized, calcic, bicarbonated, alkaline-saline water, possessing diuretic and antacid properties.

Jarvis Spring, No. 1, medicinal classification, weak alkaline b, weak total 2 or (−Ab, −T2). This is a moderately mineralized, calcic, bicarbonated, sulphated, alkaline-saline water, carbon-dioxated and sulphuretted, possessing diuretic, antacid, tonic and alterative properties.

Jarvis Spring, No. 2, is a moderately mineralized, calcic, magnesic, bicarbonated, alkaline water, carbon-dioxated, sulphuretted, possessing diuretic, antacid, tonic and alterative properties.

Iron Spring issues from the cretaceous rocks on the Crested Butte Irwin Road; a deposit of iron has oxidized on the rock near the spring. This is a lightly mineralized, ferruginous, bicarbonated, alkaline-saline water, possessing diuretic and tonic properties.

## Glenwood Hot Springs.

(*Garfield County.*)

*Postoffice*, Glenwood Springs. *Location*, in the western part of the state, midway between Denver and Salt Lake City; northwest of Colorado Springs, 170 miles; west of Denver, 280 miles. *Situation*, on the western bank of the Grand River, in a wonderful amphitheatre of the Rocky Mountains, 5764 feet above sea level. *Access*, via Glenwood Springs Depot, on the main line of the Denver & Rio Grande Railway, and via motor over the great national highways, passing through the most beautiful picturesque country in the great west. *Hotel*, the hotel is commodious and comfortable; the bed chambers are large, light and airy and luxuriously furnished. The bathing establishment is operated in connection with the hotel. In the stone bath-house, equipped with every know appurtenance of the latest design for the scientific practice of the latest knowledge in balneotherapy, is given every known type of baths, including "vapor combination baths," and at Caves No. 1, 2 and 3 are given natural mineral vapor baths for every condition where elimination is indicated. The vapor caves at Glenwood Springs are the only natural rock caverns exhaling hot mineral vapor to be found in the entire world. The red men for

centuries before the advent of the white man knew of and used these rock cavern baths; while the Indians knew not of the Turkish baths, still they obtained the same results from these natural caves. Across the park from the Glenwood Hotel, hidden among the shade trees and shrubbery, and near the bath-houses, is the great out-door mineral-water natatorium, or swimming pool—the largest in the world. There are flowing in and out daily 4,500,000 gallons of clear, warm, mineral water. These famous hot springs, about 50 in number, possess rare medicinal properties of great therapeutic value in a great variety of human ailments. An analysis of Azure-Yampah Spring, the largest of the group, with a flow of 4000 gallons per minute, is given below with 3 other springs.

GLENWOOD HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | |
|---|---|---|---|---|
| | Monmouth Spring. | Old Cave Spring. | Old Cave Spring, No. 1. | Old Cave Spring, No. 3. |
| Lithium chloride (LiCl) | none | none | none | none |
| Potassium chloride (KCl) | 887.00 | 203.50 | 905.80 | 762.80 |
| Sodium chloride (NaCl) | 17,488.00 | 15,270.00 | 15,128.00 | 16,119.00 |
| Sodium sulphate ($Na_2SO_4$) | 215.00 | 6.08 | 224.90 | 242.40 |
| Magnesium sulphate ($MgSO_4$) | 451.00 | 410.40 | ... | 392.50 |
| Calcium sulphate ($CaSO_4$) | 975.80 | 950.60 | 1247.10 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 580.30 | 414.50 | 376.40 | 1011.30 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | ... | 513.13 | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | ... | trace | trace | |
| Silica ($SiO_2$) | 37.40 | 49.40 | 48.60 | 32.40 |
| Total solids | 20,634.50 | 17,304.48 | 18,444.10 | 19,424.80 |
| Gases: | | | | |
| Carbon dioxide, excess | 157.50 | 256.50 | 112.50 | 274.50 |
| Hydrogen sulphide | 2.12 | 7.85 | 2.18 | 2.10 |
| Radio-activity, Mache units per liter | 5.32 | 0.24 | ... | 7.37 |

Monmouth Spring, medicinal classification, strong saline 2 or (+Cl2), carbon-dioxated, sulphuretted, weak radio-active. This is a very highly mineralized, sodic, muriated, sulphated, saline water, carbon-dioxated, sulphuretted, radio-activated.

Old Cave Spring, medicinal classification, strong saline 1.5 or (+Cl 1.5), carbon-dioxated, sulphuretted, very weak radio-active. This is a highly mineralized, sodic, sulphated, saline water, carbon-dioxated, sulphuretted, radio-activated.

Old Cave Spring, No. 1, medicinal classification, strong saline 1.5 or (+Cl 1.5), carbon-dioxated, sulphuretted. This is a highly mineralized, sodic, muriated, sulphated saline water, carbon-dioxated, sulphuretted.

Cave No. 3, medicinal classification, strong saline 2 or (+Cl 2),

carbon-dioxated, sulphuretted, weak radio-active. This is a highly mineralized, sodic, muriated, sulphated saline water, carbon-dioxated, sulphuretted, radio-activated.

The Glenwood Hot Mineral Springs have a flow of 6000 gallons per minute, with a temperature of 52° C. (127° F.). These waters have been used with satisfactory results in rheumatic and arthritic disorders, renal and liver disturbances, gastro-intestinal diseases, nervous affections and skin disorders. The Glenwood Hot Springs possess definite therapeutic properties indicated in a wide variety of diseases. The baths given here are effective in numerous ailments, always administered under the supervision of the medical director.

### Hartsel Hot Springs.

(*Park County.*)

*Postoffice,* Hartsel. *Location,* in central Colorado; southwest of Denver, the capital city, 60 miles; northwest of Colorado Springs, 50 miles; east of Leadville, 25 miles. *Situation,* in the heart of the Rocky Mountains, in the beautiful "South Park" section, at an elevation of about 12,000 feet above sea level. The Old Salt Spring, developed for the production of salt in the old territorial days, is 4 miles from the River Station on the Colorado & Southern Railway. The Ranch Spring, northwest of the old salt works, situated in an area of carboniferous rocks, nearby is a large body of tertiary volcanic rock. The Stinking Springs are situated on Tarryall Creek, a tributary of the South Platte River, just north of Hartsel Sulphur Springs. The Cold Soda Spring is situated in a granite area south of Hartsel. Hartsel Hot Springs are situated on the Colorado Midland Railway in South Park, arising from granite and sedimentary rock of the mesozoic age. The Iron Spring is situated at the foot of a sandstone ridge, ½ mile of Hartsel. *Access,* via the Platte River Station on the Colorado & Southern Railway, and via Hartsel Station on the Colorado Midland Railway. *Hotel,* there is a good hotel at Hartsel, offering modern conveniences and accommodations. There is also a good bath-house, modern in construction and equipment, with all conveniences for patients and guests. The analyses of the above springs shows the following mineralization:

The Old Salt Spring, medicinal classification, strong saline 2.5, calcic sulphated 2 or (+Cl 2.5, CaS2), carbon-dioxated. This is a very highly mineralized, sodic, potassic, muriated, calcic, sulphated saline water, carbon-dioxated, possessing diuretic, laxative and tonic and alterative properties. This water is very high in sodium chloride, 24.162 parts per 1,000,000.

The Ranch Spring, medicinal classification, saline, weak calcic sulphated or (Cl, −CaS). This spring belongs to the same general class as the Salt Spring, and is a moderately highly mineralized, sodic,

muriated saline water, carbon-dioxated, possessing diuretic, antacid, tonic and alterative properties.

HARTSEL HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | | |
|---|---|---|---|---|---|---|
| | Salt Works Spring. | Ranch Spring. | Stinking Spring. | Cold Soda Spring. | Hartsel Hot Spring. | Iron Spring. |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 1716.2 | 162.1 | 214.50 | 49.96 | 46.15 | 24.79 |
| Sodium chloride (NaCl) | 24,162.0 | 1665.0 | 1749.20 | 817.00 | 1284.70 | 62.28 |
| Sodium sulphate ($Na_2SO_4$) | 19.5 | ... | 22.51 | 132.60 | 333.50 | 31.69 |
| Magnesium sulphate ($MgSO_4$) | 468.3 | 153.0 | ... | ... | ... | 85.04 |
| Calcium sulphate ($CaSO_4$) | 3278.4 | 274.8 | ... | ... | 152.80 | |
| Sodium bicarbonate ($NaHCO_3$) | ... | 187.7 | 2153.20 | 161.95 | ... | 123.40 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | ... | 208.30 | 66 79 | 175.40 | 15 77 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 438.4 | 112.4 | 89.61 | 112.00 | 218.01 | 135.90 |
| Ferric oxide and alumina ($FeO_3$, $Al_2O_3$) | 17 0 | ... | ... | trace | 1.70 | trace |
| Silica " ($SiO_2$) | 92.0 | 20.4 | 12.80 | 19.50 | 45.80 | 26.10 |
| Total solids | 30,192.8 | 2539.9 | 4453.46 | 1359.80 | 2257.70 | 504.97 |
| Temperature, °C. | 8.9 | 7.8 | 16.1 | 9.8 | 56.7 | 8.9 |
| Gases: | | | | | | |
| Carbon dioxide (excess) | 119.2 | 83.3 | 651.30 | 92.9 | 111.8 | 73.96 |
| Hydrogen sulphide | .... | ... | 2.08 | | | |
| Flow in gallons per day | 8500 | 85,000 | 8000 | 1500 | 5000 | |
| Radio-activity, Mache units per liter | ... | ... | ... | ... | 111.8 | 3.5 |

Stinking Spring, medicinal classification, alkaline a, saline or (Aa, Cl), carbon-dioxated, sulphuretted. This is a moderately highly mineralized, sodic, muriated, bicarbonated alkaline-saline water, carbon-dioxated and sulphuretted, possessing antacid, diuretic, tonic and alterative properties.

The Cold Soda Spring, medicinal classification, weak saline 2, weak total 3 or (−Cl2, −T3). This is a moderately mineralized, sodic, muriated, bicarbonated saline water, carbon-dioxated, possessing diuretic, antacid and alterative properties.

Hartsel Hot Springs, medicinal classification, weak alkaline b, weak saline 3 or (−Ab, −Cl 3), thermic, strong radio-active. This is a moderately highly mineralized, thermic, sodic, muriated, sulphated saline water, carbon-dioxated, possessing diuretic and alterative properties.

The Iron Spring, medicinal classification, weak total mineralization or (−T), weak radio-active. This is a moderately mineralized, sodic, calcic, sulphated, bicarbonated alkaline-saline water, carbon-dioxated, radio-activated.

## Hot Sulphur Springs.

### (*Grand County.*)

*Postoffice,* Hot Sulphur Springs. *Location,* a little north of central Colorado; northwest of Denver, 94 miles; west of Boulder, 50 miles;

north of Leadville, 60 miles; northeast of Glenwood Springs, 80 miles; south of Walden, 40 miles. *Situation*, south of the Continental Divide, near the center of Middle Park, a mountain basin, 90 by 50 miles in area; the springs are situated near the bank of the Grand River, a tributary of the Colorado River, at an elevation of 7625 feet above sea level. *Access*, via Hot Sulphur Springs Station on the Moffat Railway, the greatest scenic railway in the world, and via the Victory Highway, the "Main Street" of America and the delight of automobilists. *Hotel*, there are three hotels, with modern conveniences. The bathing establishment is modern in construction and equipment, under the supervision of a competent physician and a trained corps of assistants and skilled attendants, for both men and women. Here will be found the most approved appliances for the scientific administration of hydrotherapy and balneotherapy. There are as many as 20 or 25 springs in the area. A strong odor of sulphuretted hydrogen pervades the vicinity, and with a favorable wind may be noticed many rods up the valley. The channel through which the waters flow are lined with a soft, yellowish-white substance, velvety to the trouch, having a sulphurous odor. The flow of the waters are said to exceed that of the celebrated Hot Springs in Arkansas. The analyses below shows the mineralization of several of the springs and also the waters of the springs all combined and as used in the various pools and hot baths.

HOT SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey. | | | | | |
|---|---|---|---|---|---|---|
| | Big Spring. | Bath House Spring. | Sulphur Spring, No. 1. | Sulphur Spring, No. 2. | Sulphur Spring, No. 3. | Combined Springs. |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 152.55 | 147.20 | 67.12 | 181.25 | 81.0 | 117.0 |
| Sodium chloride (NaCl) | 119.93 | 126.80 | 189.60 | 102.95 | 33.5 | 130.0 |
| Sodium sulphate ($Na_2SO_4$) | 203.20 | 179.80 | 177.90 | 179.40 | 343.8 | 153.0 |
| Sodium bicarbonate ($NaHCO_3$) | 968.60 | 994.60 | 1070.20 | 1038.10 | 1090.4 | 1032.2 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 9.87 | 11.20 | trace | trace | 65.0 | 21.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 64.98 | 64.13 | 66.80 | 132.20 | 135.9 | 49.3 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 15.04 | 13.92 | ... | 5.00 | | |
| Ferrous oxide and alumina ($Fe_2O_3$,$Al_2O_3$) | ... | ... | ... | ... | ... | 3.6 |
| Silica ($SiO_2$) | 31.60 | 32.50 | 24.50 | 37.50 | 16.5 | 32.0 |
| Total solids | 1565.77 | 1570.15 | 1591.90 | 1677.40 | 1766.1 | 1538.3 |
| Temperature, ° C. | 37 8 | 46.7 | 43.3 | 46.7 | 12.2 | 47.8 |
| Flow in gallons per day | 54,000 | 7200 | ... | ... | 2160 | 60,000 |
| Gases: | | | | | | |
| Hydrogen sulphide, cc. per liter | 8.22 | 10.79 | 11.11 | 12.47 | 61.09 | 20.75 |
| Carbon dioxide (excess) | 277.50 | 284.70 | 292.40 | 309.20 | 342.00 | 300.70 |
| Radio-activity, Mache units per liter | 1.62 | ... | 16.29 | 0.97 | 1.33 | 3.45 |

Big Spring, medicinal classification, weak alkaline a3, weak total 4 or (−Aa3, −T4), thermic, carbon-dioxated, sulphuretted, very weak radio-active. This is a moderately mineralized, thermic, sodic, bicarbonated, sulphated alkaline-saline (ferruginous) water, carbon-dioxated and sulphuretted, radio-activated.

Bath House Spring, medicinal classification, weak alkaline a3, weak total 4 or (−Aa3, −T4), thermic, carbon-dioxated, sulphuretted. This is a moderately mineralized, thermic, sodic, bicarbonated (ferruginous) water, carbon-dioxated, sulphuretted.

The Sulphur Spring, No. 1, medicinal classification, weak alkaline a3, weak total 4 or (−Aa3, −T4), thermic, sulphuretted, radio-active. This is a moderately mineralized, thermic, sodic, bicarbonated alkaline water, carbon-dioxated, sulphuretted, radio-activated.

Sulphur Spring, No. 2, medicinal classification, weak alkaline a3, weak total 4 or (−Aa3, −T4), thermic, carbon-dioxated, sulphuretted, very weak radio-active. This is a moderately mineralized, thermic, sodic, bicarbonated, muriated alkaline water, carbon-dioxated, sulphuretted, radio-activated.

Sulphur Spring, No. 3, medicinal classification, weak alkaline a3, weak total 4 or (−Aa3, −T4), thermic, carbon-dioxated, sulphuretted, very weak radio-active. This is a moderately mineralized, sodic, bicarbonated alkaline water, carbon-dioxated, sulphuretted, radio-activated.

Combined Spring, medicinal classification, weak alkaline a3, weak total 4 (−Aa3, −T4), thermic, carbon-dioxated, sulphuretted, weak radio-active. This is a moderately mineralized, thermic, sodic, bicarbonated and muriated alkaline water, carbon-dioxated, sulphuretted, radio-activated.

The predominating chemical constituents of these several springs are quite similar in percentage proportions. Realizing the close similarity of the waters, the medical director writes the author that the management has combined the flow of the various springs into one whole, for use in the pools and bathing establishment, and the surplus goes into the swimming natatorium.

The waters are recommended in cutaneous, hepatic, uterine, neuralgic, gouty and rheumatic disorders and in the manifestations of tertiary syphilis. As with thermic waters generally, they are not indicated in acute diseases nor in organic heart disturbances nor in predispositions to cerebral, gastric or pulmonary hemorrhage.

## Idaho Hot Springs.

### (*Clear Creek County.*)

*Postoffice,* Idaho Hot Springs. *Location,* north of the center of the state; a little northwest of Colorado Springs, 65 miles; east of Glenwood Springs, 125 miles. *Situation,* at a point where the higher foothills merge into the mountain zone of the great Rocky Mountains, at an elevation of 7500 feet above sea level. *Access,* via the Colorado Division of the Union Pacific Railway, the route lying through the Clear Creek Canyon and via motor over graded macadamized highways which pierce this picturesque "Alpine" region. The

medicinal properties and temperature of the hot waters here are of the nature of the celebrated Carlsbad waters of Bohemia, though not equal in the amount of chemical constituents or height of temperature. They are valuable waters, especially useful in rheumatism, rheumatic arthritis, cutaneous diseases and tertiary syphilis. *Hotel*, the hotel is a modern commodious structure offering every facility for the comfort and entertainment of guests. The bathing establishment is fully equipped with the latest approved appliances for the practical application of the latest knowledge in the science of hydrotherapy and balneotherapy; directed by a competent physician skilled in hydriatics. The mineral springs are located in three groups, differing but little in general composition, all issuing from an area of pre-Cambrian rocks intruded by an alkali syenite porphry. The Hot Springs issue from the earth near the contact of the pre-Cambrian rocks and a considerable body of intruded alkali syenite porphry, and have a temperature of 36.7° to 42.2° C. (98° to 108° F.). The Blue Ribbon Spring issues from near the contact of the same syenite, but the waters are cold; while the Soda Springs issue through the alluviam of the Clear Creek Valley but undoubtedly come from great depths in the bed-rock below. The similarity of the predominating chemical constituents found in the three groups of springs points to a common origin. Sodium is the most important base, but calcium, potassium and magnesium, as shown by the analyses below, are present. The waters of all the springs are highly radio-active. The waters are bottled and shipped extensively. The analyses given herewith shows the mineralization of the various springs:

IDAHO HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). Hot Soda Spring. | Cold Soda Spring. | Blue Ribbon Spring. |
|---|---|---|---|
| Potassium chloride (KCl) | trace | 120.60 | 93.06 |
| Sodium chloride (NaCl) | 117.58 | 26.58 | 64.68 |
| Sodium sulphate ($Na_2SO_4$) | 586.10 | 458.60 | 330.00 |
| Sodium bicarbonate ($NaHCO_3$) | 1230.10 | 949.70 | 614.53 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 237.26 | 51.93 | 139.66 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 561.40 | 487.80 | 361.90 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 112.50 | |
| Aluminum bicarbonate ($Al_2[HCO_3]_2$) | ... | 193.30 | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.00 | | |
| Aluminum oxide ($Al_2O_3$) | ... | 57.11 | |
| Calcium silicate ($CaSiO_3$) | 19.05 | | |
| Silica ($SiO_2$) | 58.13 | 62.00 | 55.20 |
| Total solids | 2811.86 | 2466.12 | 1659.13 |
| Gases: | | | |
| Hydrogen sulphide | none | 2.35 | none |
| Carbon dioxide (excess) | 545.8 | 466.48 | 301.1 |
| Temperature, °C. | 38.9 | 13.7 | 13 |
| Radio-activity: | | | |
| Radium emanation, curies per liter $\times 10^{10}$ | ... | 4.54 | 6.58 |
| Mache units per liter | ... | 1.23 | 1.78 |
| Permanent activity, grams of radium per liter | none | none | none |

Hot Soda Spring, medicinal classification, alkaline a, weak sulphate or (Aa, −S), thermic, carbon-dioxated. This spring, flowing at the rate of 6000 gallons in the twenty-four hours, is a moderately highly mineralized, sodic, calcic, bicarbonated and sulphated alkaline water, thermic, carbon-dioxated, possessing diuretic, antacid and tonic properties.

Cold Soda Spring, medicinal classification, weak alkaline a4, weak sulphate (−Aa4, −S), carbon-dioxated, sulphuretted, very weak radio-active. This spring, with a limited flow, is a moderately highly mineralized, sodic, calcic, aluminic, ferruginous, bicarbonated alkaline-saline water, carbon-dioxated and sulphuretted, radio-activated, possessing diuretic, tonic, alterative and restorative properties.

The Blue Ribbon Spring, medicinal classification, weak alkaline a3 (−Aa3), carbon-dioxated, very weak radio-active. This spring, with a flow exceeding 15,000 gallons in the twenty-four hours, is moderately highly mineralized, sodic, calcic, bicarbonated and muriated alkaline water, carbon-dioxated, possessing diuretic and antacid properties.

## Juniper Mineral Springs.

(*Moffat County.*)

*Postoffice*, Juniper. *Location*, in northwestern Colorado; north of the Grand Junction, about 150 miles; west of the Continental Divide, about 2 miles; north of Glenwood Springs, 80 miles; west of Denver, the capital city, about 160 miles. *Situation*, in the great Rocky Mountain region, at an elevation of about 12,000 feet above sea level. *Access*, the Denver & Salt Lake Railway passes within 6 miles to the north of Juniper Springs. *Hotel*, there is a typical western resort hotel and bath-house, with some conveniences and accommodations. There are a number of springs in this area, some hot some not. The analyses on page 287 show the mineralization and gaseous content of the various springs

Lower Bath House Springs, medicinal classification, weak alkaline a3 or (−Aa3), thermic, carbon-dioxated. This is a moderately mineralized, thermic, sodic, bicarbonated alkaline (ferruginous) water, carbon-dioxated, sulphuretted, possessing antacid, diuretic and tonic properties.

Upper Bath House Springs, medicinal classification, weak alkaline a4 or (−Aa4), thermic, carbon-dioxated, sulphuretted. This is a moderately highly mineralized, thermic, sodic, bicarbonated alkaline water, carbon-dioxated and sulphuretted, possessing diuretic and antacid properties.

Hot House Springs, medicinal classification, weak alkaline a4, or (−Aa4), carbon-dioxated. This is a moderately highly mineralized, sodic, bicarbonated alkaline water, carbon-dioxated and sulphuretted, possessing diuretic and antacid properties.

JUNIPER MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | |
|---|---|---|---|---|---|
| | Bath House Lower Spring. | Bath House Upper Spring. | Hot House Spring. | Meadow Spring. | River Spring. |
| Potassium chloride (KCl) | 95.34 | 57.21 | 36.61 | 181.20 | 471.00 |
| Sodium chloride (NaCl) | 50.66 | 135.50 | 72.79 | 1211.10 | 2382.30 |
| Sodium sulphate ($Na_2SO_4$) | 41.23 | 40.93 | 8.83 | 14.15 | 9.44 |
| Sodium bicarbonate ($Na[HCO_3]_2$) | 1078.30 | 1359.30 | 1465.40 | 1802.20 | 2570.00 |
| Magnesium bicarbonate ($MgHCO_3$) | 32.55 | 26.30 | 17.39 | 72.33 | 135.10 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 20.95 | 29.64 | 24.55 | 132.20 | 398.90 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 10.58 | 4.46 | trace | trace | trace |
| Silica ($SiO_2$) | 37.20 | 37.90 | 24.30 | 37.30 | 33.40 |
| Total solids | 1366.81 | 1691.24 | 1616.23 | 3450.48 | 6000.14 |
| Gases: | | | | | |
| Carbon dioxide (excess) | 300.50 | 373.00 | 395.70 | 529.60 | 821.90 |
| Hydrogen sulphide | 1.94 | 6.37 | 0.73 | 2.14 | trace |
| Temperature, °C. | 38.9 | 40 | 14.4 | 41.1 | 14.4 |
| Flow in gallons per day | 4500 | 3000 | 10,000 | 15,000 | 1600 |

Meadow Springs, medicinal classification, alkaline a, weak saline 3 or (Aa, −Cl 3), thermic, carbon-dioxated, sulphuretted. This is a moderately highly mineralized, thermic, sodic, bicarbonated and muriated alkaline-saline water, sulphuretted and carbon-dioxated, possessing diuretic antacid and alterative properties.

River Spring, medicinal classification, alkaline a, saline a, total 3 (Aa, Cl, T3), carbon-dioxated. This is a moderately highly mineralized, sodic, bicarbonated and muriated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, laxative and alterative properties.

## Manitou Mineral Springs.

(*El Paso County.*)

*Postoffice*, Manitou. *Location*, near the center of the state; west of Colorado Springs, 6 miles; south of Denver, 50 miles. *Situation*, immediately at the foot of Pike's Peak, 14,147 feet above sea level, almost at the very entrance of the famous gateway to the "Garden of the Gods." *Access*, via Colorado Midland Railway Station, thence a distance of three city blocks to the springs. *Hotel*, this is a resort town, with many splendid hotels, luxurious in appointments, furnishings and equipment, with many metropolitan conveniences. The combined hotels have accommodations for many thousand guests, all the year round. The Manitou Baths recently completed is one of the best-equipped institutions of the kind for the scientific application of the

principles of balneotherapy to be found at any spa in the West. The Manitou Water Company owns and controls 4 springs, the analyses of which are given below:

MANITOU MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analyst.[1] | | Analyst.[2] | |
| | Manitou Spring. | Navajo Spring. | Cheyenne Spring. | Shoshone Spring. |
| Ammonium chloride ($NH_4Cl$) | 0.15 | | | |
| Lithium chloride (LiCl) | 1.38 | trace | trace | none |
| Potassium chloride (KCl) | 136.10 | 137.7 | 213.95 | trace |
| Calcium chloride ($CaCl_2$) | ... | ... | ... | 17.31 |
| Sodium chloride (NaCl) | 303.20 | 309.8 | 242.76 | 60.25 |
| Sodium sulphate ($Na_2SO_4$) | 324.20 | 343.7 | 316.20 | |
| Calcium sulphate ($CaSO_4$) | ... | ... | ... | 318.19 |
| Sodium bicarbonate ($NaHCO_3$) | 1193.20 | 1056.7 | 1218.50 | 298.14 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 476.80 | 437.5 | 381.20 | 298.14 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1854.50 | 1877.8 | 1756.50 | 3725.80 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 5.70 | 15.6 | 12.25 | 11.14 |
| Mangano-manganic oxide ($Mn_3O_4$) | 2.40 | | | |
| Silica ($SiO_2$) | 47.20 | 49.0 | 42.50 | 58.10 |
| Total solids | 4344.83 | 4227.8 | 4183.86 | 4489.64 |
| Radio-activity: | | | | |
| Mache units, per liter | 0.04 | 3.36 | 2.32 | 8.25 |
| Radium emanations, grams, $\times 10^{-10}$, per liter | 17.60 | 20.10 | 13.10 | 47.30 |
| | 13.3 | ... | ... | 31.2 |
| Mache units ($Ra \times 10^{-10}$) | 48.1 | ... | ... | 205.0 |

[1] Bull. No. 91, U. S. Dept. Agriculture.
[2] Colorado State Geologist's Report, 1920

Manitou Spring, medicinal classification, alkaline ab2, weak saline or (Aab2, −Cl), very weak radio-active. This is a moderately highly mineralized, sodic, calcic, bicarbonated and muriated alkaline water, carbon-dioxated, sulphuretted, radio-activated.

Navajo Spring, medicinal classification, alkaline ab2, weak saline or (Aab2, −Cl), weak radio-active. This is a moderately highly mineralized, sodic, calcic, magnesic, alkaline water, radio-activated.

Cheyenne Spring, medicinal classification, alkaline ab2, weak saline or (Aab2, −Cl), weak radio-active. This is a moderately highly mineralized, sodic, calcic, bicarbonated and muriated alkaline water, carbon-dioxated.

Shoshone Spring, medicinal classification, alkaline b2 or (Ab2), weak radio-active. This is a moderately highly mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated, radio-activated; carbon-dioxide gas in excess, 1014.

These waters have been highly endorsed by the medical profession

in gastric and intestinal disorders, renal and bladder disturbances and in rheumatic and arthritic affections. The bathing establishment, in a perfectly appointed building, with the latest and most approved equipment, requisite for the administration of every known bath, has been installed: Radio-soda baths, Turkish, Russian, Roman and Nauheim baths; massage and electrotherapeutic departments; all under the supervision of competent specialists in hydrotherapy and balneotherapy. Provision has been made for every comfort of the patient—rest rooms, sleeping rooms in upper floors of the bath-house, restaurant facilities, barber shop, etc., with every known convenience at hand.

Centuries before the discovery of this continent, while mankind was in the making, the red men knew of and appreciated the health-giving properties of the Manitou waters; well-beaten paths led through the forests direct to the soda-encrusted banks of the pool where the Indians gathered on neutral ground to thank the Great Spirit for the health-laden waters which flowed from the base of their "great White Mountain," Pike's Peak. Later came the pioneer settlers, who also learned of the curative properties of the waters, and the spot became a sanctuary for the ailing, the halt and the invalid, who bathed in and drank the waters to regain health and vigor. Then a few years ago modern science revealed the health-giving "radio-activity" emanating from the Soda Springs. This discovery, the "Spirit of the Springs," as it were, breathes through the waters a message of health and happiness to suffering mankind.

Besides the charming location, the splendid hotels, the magnificent baths, the curative waters, laden with the life-giving radio-active emanations, there are many other attractive features at Manitou.

## Mount Princeton Springs.

(*Chaffee County.*)

*Postoffice,* Princeton. *Location,* in central Colorado; west of Colorado Springs, 70 miles; southeast of Glenwood Springs, 90 miles; southwest of Denver, the capital city, 125 miles. *Situation,* in the valley of the upper waters of the Arkansas River, amid the great Rocky Mountains, at an elevation of about 9000 feet above sea level. *Access,* via the Denver & Rio Grande Railway System to Mt. Princeton. *Hotel,* there are fair hotels, with modern conveniences. There is a bathing establishment, modern in construction and equipment. There are a number of springs in this area.

Hortense Spring, medicinal classification, weak mineralized or (—T) thermic, strong radio-active. This spring is located about 250 yards north of the railway station. The immediate vicinity of the spring area is alluvium, but the water arises from the great mozonite mass, of which Mt. Princeton is a part. This is the hottest spring water in

the state, and the analysis shows it to be a moderately mineralized, thermic, sodic, sulphated, alkaline-saline water, slightly carbon-dioxated, possessing diuretic and purgative properties. There is a small hotel and bath-house at this spring.

MOUNT PRINCETON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | |
|---|---|---|---|---|---|
| | Hortense Spring. | Heywood Spring. | Big Spring. | Heywood Hotel Spring. | Iron Spring. |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 3.25 | 10.49 | 24.77 | 24.77 | trace |
| Sodium chloride (NaCl) | 26.51 | 11.19 | ... | ... | 9.73 |
| Potassium sulphate ($K_2SO_4$) | ... | ... | 42.34 | 25.52 | |
| Sodium sulphate ($Na_2SO_4$) | 152.80 | 75.77 | 57.80 | 67.26 | 10.04 |
| Calcium sulphate ($CaSO_4$) | ... | ... | ... | ... | 5.98 |
| Sodium bicarbonate ($NaHCO_3$) | 152.20 | 80.61 | 73.12 | 81.89 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | trace | trace | trace | trace | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 17.67 | 36.22 | 43.44 | 28.74 | 47.56 |
| Silica ($SiO_2$) | 76.10 | 52.00 | 60.50 | 67.20 | 8.50 |
| Total solids | 401.62 | 266.28 | 301.25 | 293.38 | 81.81 |
| Temperature, °C. | 83.80 | 48.90 | 54.40 | 65.50 | 8.90 |
| Gases: | | | | | |
| Carbon dioxide (excess) | 37.58 | 30.96 | 30.96 | 29.24 | 12.90 |
| Radio-activity, Mache units per liter | 177.15 | ... | 2.54 | 54.60 | 3.61 |

The Heywood Hot Springs, medicinal classification, thermic. These springs are located a short distance below the Hortense Spring. The geological conditions are the same as Hortense Spring, and the waters probably come from the same source. This is a lightly mineralized, thermic, sodic, sulphated, bicarbonated, alkaline-saline water, slightly carbon-dioxated, possessing diuretic and antacid properties.

Big Spring, medicinal classification, thermic, weak radio-active. This is a lightly mineralized, sodic, bicarbonated, potassic sulphated alkaline-saline water, radio-active, possessing diuretic, antacid, and slight alterative properties.

Hotel Spring, medicinal classification, thermic, strong radio-active. This is a lightly mineralized, sodic, bicarbonated, potassic sulphated alkaline-saline water, radio-active, possessing antacid, diuretic and alterative properties.

Iron Spring, medicinal classification, weak radio-active. It rises 1 mile above Heywood Spring on the south side of Chalk Creek, coming through the alluvium which covers the granite and mozonite. This is a very lightly mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated, radio-activated. This is a very pure wholesome, potable water, suitable for the table and drinking purposes.

## Pagosa Hot Springs.

(*Archuleta County.*)

*Postoffice*, Pagosa Springs. *Location*, in southwestern Colorado; west of Trinidad, 135 miles; south of Glenwood Springs, 160 miles; southwest of Denver, the capital city, 360 miles; north of Santa Fe, N. M., 160 miles. *Situation*, in the town of Pagosa Springs, the county seat, lying on the banks of the San Juan River. The spring property adjoins the public park. The surrounding country is a heavily wooded mountain region. Nearby are numerous peaks, some lifting their heads above the clouds. Pagosa Saddleback Summit and Banded, all a part of the San Juan Mountain range. *Access*, via the Pagosa Springs Branch of the Denver & Rio Grande Railway, and via the state and national highways. *Hotel*, there is a modern hostelry, offering fair conveniences. This town has the unique feature of being the only town in the world where all the residences and business houses are heated with natural hot water. It has been estimated that this Big Pagosa Spring has a flow equal to a stream of water 3 feet deep and 6 feet wide, flowing at a uniform temperature of 70° C. (158° F.). There are a number of springs in this area besides the big spring just referred to, all issuing from the black shale of the upper Cretaceous age, and the waters are characteristic of this geological formation. All of the waters are highly radio-active, besides containing carbonic-acid and sulphuretted hydrogen gas.

PAGOSA HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | |
|---|---|---|---|---|---|
| | Artesian Well. | Cold Spring No. 1. | Cold Spring No. 2. | Big Pagosa. Spring. | Saw Mill Spring. |
| Lithium chloride (LiCl) | 14.8 | trace | 10.4 | 16.6 | 16.4 |
| Potassium chloride (KCl) | 395.5 | 324.2 | 179.4 | 384.4 | 330.8 |
| Sodium chloride (NaCl) | ... | 239.2 | | | |
| Sodium sulphate ($Na_2SO_4$) | 1874.7 | 1252.7 | 799.9 | 1621.4 | 1222.2 |
| Magnesium sulphate ($MgSO_4$) | 118.8 | 151.4 | 227.2 | 83.2 | 80.4 |
| Calcium sulphate ($CaSO_4$) | 94.8 | 344.3 | 157.0 | 157.3 | |
| Potassium sulphate ($K_2SO_4$) | 117.2 | ... | 293.9 | 417.4 | 25.6 |
| Sodium bicarbonate ($NaHCO_3$) | | | | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | ... | ... | ... | 84.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 818.3 | 650.2 | 860.9 | 812.0 | 1000.8 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 22.3 | 15.6 | trace | 35.7 | trace |
| Silica ($SiO_2$) | 160.2 | 35.5 | 26.4 | 68.5 | 39.2 |
| Total solids | 3916.6 | 2911.1 | 2555.1 | 3560.5 | 3399.6 |
| Temperature, ° C. | 50 | 12.5 | ... | 72.2 | 15 |
| Flow in gallons per day | 72,000 | 7200 | 2800 | 1,152,000 | 3080 |
| Gases: | | | | | |
| Hydrogen sulphide, cc. per liter | 7.40 | 7.74 | 8.4 | 4.60 | 16.0 |
| Carbon dioxide, cc. per liter | 227.70 | 180.30 | 233.7 | 229.20 | 296.9 |
| Radio-activity, Mache units per liter | 1.79 | 0.62 | ... | 3.34 | |

Artesian Well, medicinal classification, weak alkaline b2, sulphated or (−Ab2, S), thermic, very weak radio-active, carbon-dioxated, sulphuretted. This is a moderately highly mineralized, thermic, sodic, magnesic, calcic, sulphated, saline (ferruginous) water, carbon-dioxated, sulphuretted and radio-activated, possessing diuretic, laxative, tonic and alterative properties.

Cold Spring, No. 1, medicinal classification, weak alkaline b2, weak sulphated 4, weak saline or (−Ab2, −S4, −Cl), very weak radio-active, carbon-dioxated, sulphuretted. This is a moderately highly mineralized, sodic, calcic, sulphated and muriated, saline (ferruginous) water, carbon-dioxated, sulphuretted and radio-activated, possessing diuretic, laxative and tonic properties.

Cold Spring, No. 2, medicinal classification, weak alkaline b2, weak sulphated 4 or (−Ab2, −S4), carbon-dioxated, sulphuretted. This is a moderately highly mineralized, sodic, potassic, calcic and magnesic sulphated, calcic bicarbonated saline water, carbon-dioxated and sulphuretted, possessing diuretic, purgative and slight antacid properties.

The Big Pagosa Spring, medicinal classification, weak alkaline b2, sulphated, weak saline or (−Ab2, S, −Cl 2), weak radio-active, carbon-dioxated, sulphuretted. This is a moderately highly mineralized, thermic, sodic, potassic, calcic and magnesic sulphated, saline (lithic, ferruginous) water, carbon-dioxated, sulphuretted and radio-activated.

The Saw Mill Spring, medicinal classification, weak alkaline b3, weak sulphated 3 or (−Ab3, −S3), carbon-dioxated, sulphuretted. It is a moderately highly mineralized, sodic sulphated and calcic bicarbonated alkaline-saline water, sulphuretted, carbon-dioxated, possessing diuretic, antacid and laxative properties.

The Big Pagosa Hot Spring resembles very closely in the percentage of its chemical constituents that of the famous Carlsbad Spring in Bohemia, Germany. A comparative analysis of the two waters are almost identical: Temperature of Pagosa, 72.2° C.; Carlsbad, 73.3° C. Altitude, Pagosa, 7000 feet; Carlsbad, 12,000 feet. The waters are used and highly recommended in the following diseased conditions: Chronic rheumatism, chronic arthritis, arthritis deformans, chronic eczema, chronic gastric catarrh, chronic diarrhea and secondary syphilis. The waters are also of value in the treatment of renal and vesical calculi and in hepatic disorders. Surgeons of the U. S. Army have made some very interesting and valuable reports on a series of cases treated with these hot waters.

## Poncho Hot Springs.

### (*Chaffee County.*)

*Postoffice*, Poncho Springs. *Location*, a little to the south of central Colorado; southwest of Denver, the capital city, 100 miles; east of

Gunnison, 45 miles; northwest of Trinidad, 145 miles. *Situation*, in the beautiful valley of Poncho Creek, at an elevation of 8000 feet above sea level, and surrounded by a broken mountainous region, rough and rugged, lying amid the foothills of the upper end of the Sangre de Christo Range of mountains which forms an impressive panorama of great scenic mountain grandeur. *Access*, via the Denver & Rio Grande Railway to Salida, thence by motor over splendid mountain highways, leading through a beautiful picturesque region 7 miles to the springs. *Hotel*, there is a good resort hostelry, with modern conveniences. There are two bathing establishments, modern in construction and equipment; a large out-door natatorium and more extensive improvements are planned. There are about 40 springs in this area, of which we present analyses of 4 hot and 1 cold:

PONCHO HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geologica Survey). | | | | |
|---|---|---|---|---|---|
| | Laundry Spring. | West Mound Spring. | East Mound Spring. | Gulch Spring. | Cold Spring. |
| Potassium chloride (KCl) | 31.5 | 69.6 | 40.0 | 82.4 | 7.6 |
| Sodium chloride (NaCl) | 65.5 | 35.6 | 58.9 | 25.6 | 11.0 |
| Sodium sulphate ($Na_2SO_4$) | 306.7 | 291.8 | 293.8 | 318.7 | 26.3 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | ... | ... | 9.9 |
| Sodium bicarbonate ($NaHCO_3$) | 202.3 | 208.9 | 205.3 | 184.1 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 16.3 | 19.9 | 13.8 | 16.3 | 40.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 79.7 | 82.5 | 71.6 | 89.8 | 140.7 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.8 | 7.8 | 9.4 | 9.4 | 5.8 |
| Silica ($SiO_2$) | 15.4 | 75.5 | 89.6 | 79.5 | 76.7 |
| Total solids | 759.9 | 797.3 | 773.1 | 803.4 | 257.0 |
| Temperature, °C. | 54.4 | 65.9 | 67.8 | 63.3 | 8.9 |
| Gases: | | | | | |
| Carbon dioxide (excess), cc. per liter | 80.5 | 84.9 | 79.70 | 79.80 | 51.7 |
| Radio-activity, Mache units per liter | ... | 205.2 | 3.67 | 71.25 | 2.5 |

Laundry Spring, medicinal classification, weak total mineralization 2 or (−T2), thermic. This is a moderately mineralized, thermic, sodic sulphated and bicarbonated alkaline-saline water, carbon-dioxated.

The West Mound Spring, medicinal classification, weak total mineralization 2 or (−T2), thermic, strong radio-active. This is a moderately mineralized, thermic, sodic, sulphated and bicarbonated alkaline-saline (ferruginous) water, carbon-dioxated, radio-activated.

The East Mound Spring, medicinal classification, weak total mineralization 2 or (−T2), thermic, weak radio-active. This is a moderately mineralized, thermic, sodic, sulphated and bicarbonated alkaline-saline water, carbon-dioxated, radio-activated.

The Gulch Spring, medicinal classification, weak total mineralization

2 or (−T2), thermic, strong radio-active. This is a moderately mineralized, thermic, sodic, sulphated and bicarbonated alkaline-saline water, carbon-dioxated, radio-activated.

The Cold Spring, medicinal classification, weak radio-active. This is a moderately mineralized, calcic, ferruginous, bicarbonated alkaline water, carbon-dioxated, radio-activated.

The first 4 hot springs are quite similar in the percentage of their predominating chemical constituents, as well as in their therapeutic properties. They possess diuretic, antacid and slight tonic properties. They should be useful in the treatment of gastric digestive disorders due to acidity and hyperacidity; they contain sufficient sulphate radicles to stimulate slight bowel action and also to stimulate the hepatic function and that of the gall ducts. These waters have been used with success in the treatment of irritation of the genito-urinary tract. The Cold Spring is a decided alkaline water, very bland and soft, a delightful beverage and does not produce a feeling of "fulness" after partaking liberally. The administration of the hot waters in baths has had a very salutary effect in rheumatic disturbances and in chronic joint disturbances, as well as in the more disturbing chronic skin affections.

## Radio-active Hot Mineral Springs.

### (*Ouray County.*)

*Postoffice*, Ouray. *Location*, in southwestern Colorado; southwest of Denver, the capital city, 289 miles; south of Glenwood Springs, 110 miles; east of Montecello, Utah, 100 miles. *Situation*, in a picturesque amphitheatre of the Rocky Mountains, at an elevation of 7500 feet above sea level. The climatic conditions around Ouray are quite exceptional, sunny days predominating, with warm pleasant days and refreshing nights during the summer. The highest temperature observed is about 32.2° C. (90° F.), the lowest, −14.2° C. (5° F.) during the winter. *Access*, via Ouray Station on the Denver & Rio Grande Railway System, thence only a short distance to the springs. *Hotel*, there are a number of good hotels with modern conveniences and appointments. There are a number of bathing establishments, modern in construction and equipment.

The geological formation of this region is interesting, the city being surrounded by sedimentary rocks of Paleozoic and Mesozoic Ages. To the east and west tertiary volcanic rocks cover large areas. To the south, near Uncompahgre Peak, uncompahgre formations of the pre-Cambrian age forms outcrops along the valley. There are a number of springs in this area, estimated to be about 100, sulphated waters predominating, but differing considerably in details of composition. A few of the springs are very highly mineralized. We present below the analyses of several which shows the chemical con-

stituents found on analysis. The majority of the springs in this area are highly radio-active, which adds to their therapeutic properties and medicinal usefulness.

RADIO-ACTIVE HOT MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | |
|---|---|---|---|---|---|
| | Bath House Spring. | Big Spring. | Fish Pond Spring. | Hot Spring. | Pavilion Spring. |
| Lithium chloride (LiCl) | ... | ... | ... | trace | 6.8 |
| Potassium chloride (KCl) | 15.3 | 10.9 | 34.4 | 50.9 | 85.5 |
| Sodium chloride (NaCl) | 2.1 | 2.6 | 25.4 | 5.3 | 7.7 |
| Sodium sulphate ($Na_2SO_4$) | 13.0 | 9.8 | 150.4 | 194.3 | 240.9 |
| Magnesium sulphate ($MgSO_4$) | 19.2 | 63.4 | 26.7 | 22.2 | 54.9 |
| Calcium sulphate ($CaSO_4$) | 31.2 | 30.0 | 500.3 | 599.4 | 1146.7 |
| Sodium bicarbonate ($NaHCO_3$) | 182.4 | | | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | ... | 164.6 | 228.9 | 281.9 | 49.7 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 7.5 | ... | ... | ... | 41.0 |
| Calcium silicate ($CaSiO_3$) | 13.7 | ... | ... | ... | 97.0 |
| Silica ($SiO_2$) | 22.1 | 23.1 | 37.4 | 39.0 | 2.1 |
| Total solids | 366.5 | 317.8 | 1001.5 | 1193.0 | 1732.6 |
| Temperature, °C. | 35.6 | 36.7 | 37.8 | 48.9 | 71.1 |
| Flow in gallons per day | 288,000 | 432,000 | 14,400 | 43,200 | 28,800 |
| Gases: | | | | | |
| Carbon dioxide in excess, cc. per liter | 49.5 | 48.00 | 62.1 | 76.50 | 13.50 |
| Radio-activity, Mache units per liter | 2.8 | 41.14 | ... | 9.99 | 1.72 |

The Bath House Spring, medicinal classification, thermic, weak radio-active. This is a lightly mineralized, thermic, sodic, bicarbonated, sulphated alkaline water, carbon-dioxated and radio-activated.

The Big Spring, medicinal classification, thermic, radio-active. This is a lightly mineralized, thermic, calcic, bicarbonated, sulphated alkaline (potassic) water, carbon-dioxated and radio-activated.

The Fish Pond Spring, medicinal classification, weak calcic sulphated 2 or (−CaS2), thermic. This is a moderately mineralized, thermic, calcic, sodic sulphated saline water, carbon-dioxated, radio-activated.

The Hot Spring, medicinal classification, weak calcic sulphated 2 or (−CaS2, −T3), thermic, weak radio-active. This is a moderately mineralized, thermic, calcic, sodic, sulphated saline water, carbon-dioxated and radio-activated.

The Pavilion Spring, medicinal classification, weak calcic sulphated 3 or (−CaS3), −T4), thermic, very weak radio-active. This is a moderately mineralized, thermic, calcic and sodic, sulphated saline ferruginous, potassic) water, carbon-dioxated, radio-activated.

The first 2 springs are moderately mineralized and are very much alike in their predominating chemical constituents, with the exception

of the alkalies which in the first is sodium bicarbonate and in the second is calcium bicarbonate, otherwise they are very similar and useful in digestive disorders due to acidity. They are also useful in securing elimination from the intestinal tract and allaying irritation of the renal and vesical organs. They are also recommended in the treatment of rheumatism, gout, etc.

The other 3 springs are quite similar in the percentage proportions of their predominating chemical constituents, carrying much higher sulphate ions, are more potent in laxative action; they will also stimulate the hepatic function and liquefy the contents of the gall ducts. The Pavilion Spring carries a liberal iron content, and is therefore a valuable tonic and alterative in addition to its lithium content, which recommends its application as a solvent of renal and cystic concretions. The hot baths with these waters are of great potency in the treatment of chronic rheumatism and rheumatoid arthritis, diseases of the skin, etc.

## Steamboat Springs.

(*Routt County.*)

*Postoffice,* Steamboat Springs. *Location,* in northwestern Colorado; northwest of Denver, the capital city, 116 miles; north of Glenwood Springs, 70 miles. *Situation,* in a bend in the Yampa River, where it suddenly changes from a northerly flow and turns sharply to the west, at an elevation of 8000 feet above sea level. The Mountain Range here follows the contour of the river, lifting its lofty summit covered all summer with ever-melting, but never melted snow on two sides of the valley to the north and to the east. *Access,* via the Denver & Salt Lake Railway, which furnishes convenient schedule to this inviting resort. *Hotel,* there are ample hotel accommodations. The bathing establishment is modern in construction and equipment every facility at hand for administering the latest knowledge in balneotherapy. There are more than 100 springs in this area. The waters issue forth near the contact of the pre-Cambrian area of the Park Range and the steeply upturned mesozoic sedimentary rocks. The oldest and lowest of the stratified rocks are probably of Jura-Triassic Age. Following these are the Dakota limestones and shales which in turn are overlaid by the Mancos Group. In the spring zone these sedimentary rocks are charged with sulphur and salts deposited from spring waters. At a distance from the spring area the formations have their normal appearance and composition.

Magnesia Spring, medicinal classification, alkaline a2, saline or (Aa2, Cl), carbon-dioxated, very weak radio-activated. This is a highly mineralized, sodic, bicarbonated and muriated alkaline-saline (ferruginous) water, carbon-dioxated, radio-activated, possessing diuretic, antacid, tonic and alterative properties.

The Bath House Spring, medicinal classification, weak saline, weak

total 2 or (−Cl, T2), thermic, very weak radio-activated. This is a moderately mineralized, sodic, muriated, sulphated, bicarbonated saline water, carbon-dioxated, radio-activated, possessing diuretic, antacid and slight laxative action.

STEAMBOAT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey, Bull. No. 11). | | | | | |
|---|---|---|---|---|---|---|
| | Magnesia Spring. | Bath House Spring. | Heron Spring. | Bubbling Spring. | Hot Spring. | Steamboat Spring. |
| Lithium chloride (LiCl) | trace | none | none | none | none | trace |
| Potassium chloride (KCl) | 295.60 | 31.22 | 100.34 | 41.95 | 21.24 | 309.90 |
| Sodium chloride (NaCl) | 1986.60 | 509.60 | 639.80 | 2086.80 | 209.10 | 2110.90 |
| Sodium sulphate ($Na_2SO_4$) | 718.11 | 209.06 | 317.60 | 816.15 | 64.34 | 886.70 |
| Sodium bicarbonate ($NaHCO_3$) | 3774.50 | 103.70 | 1350.70 | 3468.00 | 202.03 | 3661.70 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 191.96 | ... | 332.60 | 216.90 | ... | 173.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 455.96 | 53.04 | 666.70 | 569.50 | ... | 490.90 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 12.25 | ... | ... | 10.58 | ... | 16.15 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | ... | 2.25 | 5.00 | ... | 2.50 | |
| Calcium silicate ($CaSiO_3$) | ... | 22.76 | 34.93 | ... | 22.01 | |
| Silica ($SiO_2$) | 84.80 | 35.81 | ... | 22.20 | 73.76 | 23.20 |
| Total solids | 7519.78 | 967.44 | 3447.67 | 7232.08 | 601.55 | 7672.45 |
| Temperature, °C. | 24 | 40 | 24 | 23.8 | 64.4 | |
| Gases: | | | | | | |
| Carbon dioxide, cc. per liter | 1173 | 36.13 | 634.64 | 1130.50 | 50.74 | 1148.20 |
| Hydrogen sulphide | trace | trace | ... | 14.71 | ... | 17.52 |
| Radio-activity, Mache units per liter | 1.79 | 1.31 | 9.5 | 17.8 | ... | 0.65 |

The Heron Spring, medicinal classification, alkaline a, weak saline 2 or (Aa, −Cl 2), carbon-dioxated, weak radio-active. This is a moderately mineralized, sodic, bicarbonated, muriated, sulphated, alkaline-saline (ferruginous, potassic) water, carbon-dioxated, radio-activated, possessing diuretic, antacid, slight laxative, tonic and alterative properties.

The Bubbling Spring, medicinal classification, alkaline a2, saline, weak sulphated 2 or (Aa2, Cl, −S2), sulphuretted, carbon-dioxated, radio-active. This is a highly mineralized, sodic, bicarbonated and muriated alkaline-saline water, carbon-dioxated, radio-activated and sulphuretted, possessing diuretics, antacid, tonic and alterative action.

The Hot Spring, medicinal classification, weak mineralization 2 or (−T2), thermic. This is a moderately mineralized, thermic, sodic, muriated and bicarbonated alkaline-saline water, possessing diuretic and antacid properties.

The Steamboat Spring, medicinal classification, alkaline a2, saline, weak sulphated or (Aa2, Cl, −S2), carbon-dioxated, sulphuretted, very weak radio-active. This spring is so named from a noise or rumbling sound, as the water escapes from the earth, resembling the puffings of a steamboat. This is a highly mineralized, sodic, bicarbonated and muriated alkaline-saline (potassic) water, sulphuretted and carbon-dioxated.

STEAMBOAT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey, Bull. No. 11). | | | | | |
|---|---|---|---|---|---|---|
| | Crawford Spring. | Soda Spring. | Magnesium Spring. | Moffat Spring. | Second Spring. | Rumbling Spring. |
| Lithium chloride (LiCl) | trace | ... | trace | trace | trace | trace |
| Potassium chloride (KCl) | 237.4 | 139.20 | 191.8 | 236.4 | 300.30 | 66.7 |
| Sodium chloride (NaCl) | 1974.8 | 645.10 | 1674.6 | 2157.4 | 2132.00 | 2265.7 |
| Sodium sulphate ($Na_2SO_4$) | 807.9 | 399.50 | 746.8 | 875.0 | 863.30 | 842.8 |
| Sodium bicarbonate ($NaHCO_3$) | 3697.7 | 1201.00 | 3035.2 | 3798.3 | 3951.00 | 3469.0 |
| Magnesium bicarbonate ($Mg[CHO_3]_2$) | 215.6 | 327.30 | 151.6 | 191.3 | 193.20 | 151.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 523.4 | 780.10 | 378.2 | 451.7 | 469.10 | 440.8 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 6.1 | 5.57 | 12.2 | 8.3 | 7.24 | 9.5 |
| Silica ($SiO_2$) | 29.90 | 22.70 | 32.0 | 25.3 | 24.60 | 29.5 |
| Total solids | 7497.8 | 3460.47 | 6222.4 | 7743.7 | 7940.74 | 7284.7 |
| Temperature, °C. | ... | 15 | ... | ... | 26 | 24.5 |
| Gases: | | | | | | |
| Carbon dioxide, excess | 1178.70 | 624.6 | 945.90 | 1177.00 | 1221.80 | 1078.80 |
| Hydrogen sulphide | 19.37 | none | 24.19 | 16.30 | 24.54 | 27.91 |
| Radio-activity, Mache units per liter | ... | 16.28 | ... | ... | ... | 0.89 |

The Crawford Spring, medicinal classification, alkaline a2, saline, weak sulphated 2 or (Aa2, Cl, −S2), carbon-dioxated, sulphuretted. This is a highly mineralized mineralized, sodic, bicarbonated and muriated sulphated alkaline-saline (potassic) water, carbon-dioxated, sulphuretted, possessing diuretic, antacid, laxative and tonic properties.

The Soda Spring, medicinal classification, alkaline ab, weak saline 2 or (Aab, −Cl 2), carbon-dioxated, radio-activated. This is a moderately highly mineralized, sodic, bicarbonated, muriated, alkaline-saline (potassic) water, carbon-dioxated, radio-activated, possessing diuretic, slight laxative and tonic properties.

The Magnesium Spring, medicinal classification, alkaline a2, saline, weak sulphated 2 or (Aa2, Cl, −S2), carbon-dioxated, sulphuretted. This is a highly mineralized, sodic, bicarbonated, muriated, sulphated alkaline-saline (potassic, ferruginous) water, carbon-dioxated, sulphuretted, possessing diuretic, antacid, laxative, tonic and alterative actions.

The Moffat Spring, medicinal classification, alkaline a2, saline, weak sulphated 2 or (Aa2, Cl, −S2), carbon-dioxated, sulphuretted. This is a highly mineralized, sodic, bicarbonated, muriated and sulphated alkaline-saline water, carbon-dioxated, sulphuretted, possessing diuretic, antacid, laxative, tonic and alterative actions.

Second Spring, medicinal classification, alkaline a2, saline, weak sulphated 2 or (Aa2, Cl, −S2), carbon-dioxated, sulphuretted. This is a highly mineralized, sodic, bicarbonated, muriated and sulphated alkaline-saline water, carbon-dioxated and sulphuretted, possessing similar therapeutic properties to the Moffat Spring.

The Rumbling Spring, medicinal classification, alkaline a2, saline, weak sulphated 2 or (Aa2, Cl, −S2), carbon-dioxated, very weak radio-active. This is a highly mineralized, sodic, bicarbonated, muri-

ated and sulphated alkaline-saline water, carbon-dioxated, sulphuretted and radio-activated.

The waters from these springs were known to and used by the red men of the forest centuries before the coming of the "pale face." Their use has been very efficient in the treatment of rheumatism and rheumatic joint disturbances, skin diseases, etc. The hot sulphur baths are said to be efficacious in the treatment of tertiary syphilis and chronic skin affections are said to be helped by the hot baths. Many types of arthritis yield to the "bathing treatment" and drinking cure.

### The Springs of Manitou.

(*El Paso County.*)

*Postoffice*, Manitou. *Location*, in central Colorado; west of Colorado Springs, 5 miles; south of Denver, the capital city, 50 miles; north of Pueblo, 45 miles; east of Crested Butte, 110 miles; south of Leadville, 75 miles. *Situation*, in the midst of the Colorado Rockies, at the foot of Pike's Peak, at an elevation of 14,147 feet above sea level. Few areas in the world present a greater number and variety of wild, weird, grotesque and romantic features than are found in this vicinity: Within a short distance the "Garden of the Gods," 3 miles; Rainbow Falls, 1½ miles; Crystal Park, 3 miles; Glen Eyrie, 5 miles. The summit of the celebrated Pike's Peak may be reached by cog-wheel railway, distance 12 miles to the pinnacle, or over a wonderful automobile highway. *Access*, via the Colorado Midland Railway and the terminus of all the important western roads. *Hotel*, the hotel is a modern caravansary, recently remodeled and refurnished with a lavish hand. The bathing establishment, recently constructed at a cost of more than $400,000, is a model of perfection, and the equipment is the last word in balneotherapeutic refinements, altogether the most complete hydrotherapeutic establishment in the West. It is directed by a competent hydrologist and trained assistants, masseurs and masseuses. There are a large number of springs in this vicinity. The Soda Springs area has already been described (p. 288).

The Sequoyah Spring, medicinal classification, alkaline ab3 or (Aab3). This is a moderately mineralized, calcic, sodic, bicarbonated and sodic, muriated, sulphated alkaline-saline water, carbon-dioxated.

The Mansion Spring, medicinal classification, alkaline b, weak saline, weak sulphated or (Ab, −Cl, −S), weak radio-activated. This is a moderately highly mineralized, sodic, calcic, bicarbonated, muriated alkaline water, carbon-dioxated, radio-activated.

The Seven Minute Spring, medicinal classification, alkaline ab or (Aab), very weak radio-activated. This is a moderately highly mineralized, sodic, calcic, bicarbonated alkaline water, carbon-dioxated, radio-activated.

The Navajo Geyser Spring, medicinal classification, alkaline ab,

THE SPRINGS OF MANITOU.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | |
|---|---|---|---|---|---|
| | Sequoyah Spring. | Mansion Spring. | Seven Minute Spring. | Navajo Geyser. | Hiawatha Spring. |
| Lithium chloride (LiCl) | trace | trace | trace | trace | none |
| Potassium chloride (KCl) | ... | 144.9 | 121.80 | 198.3 | trace |
| Sodium chloride (NaCl) | 250.20 | 476.6 | 225.10 | 286.5 | 32.97 |
| Magnesium chloride ($MgCl_2$) | | | | | |
| Potassium sulphate ($K_2SO_4$) | 151.67 | | | | |
| Sodium sulphate ($Na_2SO_4$) | 225.37 | 391.5 | 239.40 | 348.1 | 26.34 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | ... | ... | 36.48 |
| Sodium bicarbonate ($NaHCO_3$) | 2203.88 | 625.5 | 912.40 | 1220.0 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 455.03 | | | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 2655.29 | 1884.6 | 1351.40 | 1895.6 | 315.2 |
| Lithium bicarbonate ($Li[HCO_3]_2$) | 4.78 | | | | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 7.8 | 6.24 | 16.4 | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 22.03 | | | | |
| Silica ($SiO_2$) | 30.80 | 21.4 | 26.10 | 48.6 | 18.50 |
| Total solids | 5999.05 | 3552.3 | 2882.44 | 4014.0 | 429.49 |
| Temperature, °C. | ... | 24.0 | 13.3 | 14.8 | 17.8 |
| Radio-activity: | | | | | |
| Mache units | ... | 3.74 | 1.98 | 4.48 | |
| Grams of radium, $\times 10^{-10}$ | ... | 22.40 | 11.50 | 26.70 | |
| Grams of radium per liter | ... | 15.40 | ... | 47.00 | |
| Flow in gallons per day | ... | 720 | 4200 | 5700 | |

THE SPRINGS OF MANITOU.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). | | | | |
|---|---|---|---|---|---|
| | Ute Cheif Spring. | Ute Chief Magnetic Spring. | Iron Geyser Spring. | Ute Iron Spring. | Ouray Iron Spring. |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 108.5 | 5.15 | 26.32 | 76.87 | 137.8 |
| Sodium chloride (NaCl) | 177.2 | 205.20 | 270.85 | 366.30 | 142.5 |
| Sodium sulphate ($Na_2SO_4$) | 192.5 | 177.80 | 61.92 | 490.20 | 315.6 |
| Calcium sulphate ($CaSO_4$) | ... | ... | 121.07 | | |
| Sodium bicarbonate ($NaHCO_3$) | 612.9 | 534.10 | ... | 240.70 | 1140.8 |
| Magnesium bicarbonate ($[MgHCO_3]_2$) | 369.0 | 316.10 | ... | 243.50 | 185.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 763.8 | 1554.00 | 1629.70 | 1000.80 | 699.9 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 11.1 | ... | 7.80 | trace | 30.5 |
| Silica ($SiO_2$) | 28.6 | 2.18 | 76.30 | 55.60 | 73.0 |
| Total solids | 3263.0 | 2814.15 | 2273.42 | 2475.97 | 2724.7 |
| Temperature, °C. | ... | 13.8 | 11.1 | 10.2 | 14.4 |
| Radio-activity: | | | | | |
| Mache units | ... | 1.35 | 2.34 | 3.25 | 1.41 |
| Grams of radium $\times 10^{-10}$ | ... | 8.20 | 14.00 | 20.00 | 8.45 |
| Flow in gallons per day | ... | 3600 | ... | 1800 | 2800 |

weak saline or (Aab, −Cl) weak radio-active. This is a moderately highly mineralized, sodic, calcic, bicarbonated, muriated, alkaline (ferruginous) water, carbon-dioxated, radio-activated.

The Hiawatha Spring, medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated.

Ute Chief Spring, medicinal classification, alkaline ab, total 1.6 (Ab, T1.6). This is a moderately highly mineralized, calcic, sodic, magnesic, bicarbonated alkaline (potassic, ferruginous) water, carbon-dioxated, radio-activated.

Ute Chief Magnetic Spring, medicinal classification, alkaline b or (Ab), very weak radio-activated. This is a moderately highly mineralized, calcic, sodic, bicarbonated alkaline water, carbon-dioxated, radio-activated.

The Iron Geyser Spring, medicinal classification, weak alkaline b4 or (−Ab4), weak radio-activated. This is a moderately highly mineralized, calcic, bicarbonated, sulphated alkaline-saline water, carbon-dioxated, radio-activated.

The Ute Iron Spring, medicinal classification, alkaline b, weak saline, weak sulphated or (Ab, −Cl, −S), weak radio-activated. This is a moderately highly mineralized, calcic, sodic, bicarbonated and muriated, sulphated alkaline-saline water, carbon-dioxated, radio-activated.

The Ouray Iron Spring, medicinal classification, alkaline ab or (Aab), very weak radio-activated. This is a moderately highly mineralized, sodic, calcic, bicarbonated alkaline (ferruginous) water, carbon-dioxated, radio-activated.

Practically all of these waters are heavily charged with radium emanations, which add to their therapeutic potency and efficiency. It is claimed that the Manitou waters are perhaps more highly radio-active than any waters in this country.

The waters from these springs are used with much success in disordered conditions of the digestive tract, especially where the disturbance is due to acidity and hyperacidity. One eminent physician says: "A glass of this water will give relief in pyrosis, acid eructations or flatulence, and its habitual use prevents the recurrence of these disagreeable symptoms." These waters are also highly endorsed in renal and bladder disturbances. The iron waters are highly beneficial where an assimilable iron tonic is indicated. (See also Chapter XV.)

## Wagon Wheel Gap Springs.

(*Mineral County.*)

*Postoffice*, Wheel Gap. *Location*, in southwestern Colorado; southwest of Denver, the capital city, 170 miles; southwest of Colorado Springs, 130 miles; south of Glenwood Springs, 120 miles. *Situation*, in the heart of the Rocky Mountains, south of the Continental Divide

and north of the San Juan Mountains, between which runs the Rio Grande River. The springs are situated on Goose Creek and in the valley of same just before it empties into the river, at an elevation of 8500 feet above sea level. *Access*, via the Denver & Rio Grand Railways, thence by motor only a short distance to the springs. *Hotel*, there is accommodation; a resort hostelry with some conveniences. Bathing facilities are ample, two swimming pools. The springs are several in number, of which we present the analyses of the following:

WAGON WHEEL GAP SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Colorado Geological Survey). Boiling Spring. | Saline Hot Spring. | Sulphur Hot Spring. |
|---|---|---|---|
| Lithium chloride (LiCl) | 8.3 | 8.3 | trace |
| Potassium chloride (KCl) | 416.9 | 66.7 | 38.1 |
| Sodium chloride (NaCl) | ... | 274.6 | 308.5 |
| Potassium sulphate ($K_2SO_4$) | 127.9 | | |
| Sodium sulphate ($Na_2SO_4$) | 206.3 | 216.9 | 255.5 |
| Sodium bicarbonate ($NaHCO_3$) | 1289.2 | 908.7 | 951.1 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 105.9 | 113.7 | 105.9 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 30.8 | 293.6 | 292.0 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | trace | 26.7 | 22.3 |
| Calcium silicate ($CaSiO_3$) | 175.1 | | |
| Silica ($SiO_2$) | 3.8 | 75.2 | 87.7 |
| Total solids | 2364.2 | 1984.4 | 2061.1 |
| Temperature, °C. | 51.8 | 41.1 | 52 |
| Radio-activity, Mache units per liter | 4.26 | 36.8 | 5.39 |
| Flow in gallons per day | 72,000 | 12,000 | 15,000 |

The Boiling Spring, medicinal classification, weak alkaline a4, weak saline or (−Aa4, −Cl), thermic, weak radio-activated. This is a moderately highly mineralized, thermic, sodic, magnesic, bicarbonated, alkaline-saline (lithic) water, carbon-dioxated, sulphuretted, radio-activated, possessing antacid, diuretic, anlithic and alterative properties.

Hot Saline Spring, medicinal classification, weak alkaline a3 or (−Aa3, T), thermic, radio-activated. This is a moderately highly mineralized, thermic, sodic, bicarbonated, muriated, alkaline-saline (ferruginous) water, carbon-dioxated, sulphuretted, radio-activated, possessing diuretic, antacid, antilithic, tonic and alterative properties.

Hot Sulphur Spring, medicinal classification, weak alkaline a3 or (−Aa3, T), thermic, weak radio-active. This is a moderately highly mineralized, thermic, sodic, calcic, ferruginous, bicarbonated, alkaline-saline water, carbon-dioxated, radio-activated, possessing diuretic, antacid, tonic and alterative properties.

## Waunita Hot Radium Springs.

(*Gunnison County.*)

*Postoffice*, Waunita. *Location*, southwest from the center of the state; east of Gunnison, the county seat, 25 miles; west of Colorado Springs, 75 miles; south of Denver, about 125 miles. *Situation*, in a park-like spot, in a beautiful valley, nestling in the fastness of the Colorado Rocky Mountains, surrounded by rugged hills and stately peaks, some of which lift their heads 9000 feet above sea level, presenting a scene of rare charm and beauty. *Access*, via Dolye Station, on the Denver & Rio Grande Railway, thence by motor over splendid highways which wind in and out through a beautiful, picturesque region, rugged, rough and romantic, 6 miles to the springs. *Hotels*, there is a comfortable hostelry. The bathing establishment is equipped with all modern appliances for the application of the latest teaching in hydrotherapy and balneotherapy: Steam baths, electric baths, hot radium baths, mud baths and a large natatorium and some public baths. There are 300 springs in this area, two groups of 150 each, about ½ mile apart, with a combined flow of 5,000,000 gallons daily. Fourteen of the springs have been analyzed, and we present herewith the analyses of 3 of the more important springs:

WAUNITA HOT RADIUM SPRINGS.

| | Parts per 1,000,000. | | |
|---|---|---|---|
| | (Analyst, R. W. Webster.) | (Analyst, Colorado Geological Survey.) | |
| Hypothetical combinations. | Mary Estel Spring. | Lower Spring. | Garage Spring. |
| Ammonium chloride ($NH_4Cl$) | 0.029 | | |
| Potassium chloride (KCl) | 26.910 | 4.8 | 28.6 |
| Sodium chloride (NaCl) | 18.860 | 41.4 | 11.6 |
| Sodium sulphate ($Na_2SO_4$) | 280.020 | 269.0 | 265.0 |
| Sodium nitrate ($NaNO_3$) | 0.302 | | |
| Sodium nitrite ($NaNO_2$) | 80.024 | | |
| Sodium bicarbonate ($NaHCO_3$) | 88.245 | 187.1 | 201.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 49.120 | 21.8 | 20.9 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 31.490 | 22.3 | 15.6 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 5.6 | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$ | 4.000 | ... | 4.0 |
| Manganese oxide ($Mn_3O_4$) | none | trace | trace |
| Silica ($SiO_2$) | 12.000 | 85.7 | 75.2 |
| Total solids | 491.000 | 637.7 | 642.2 |
| Radio-activity, emanation, per liter, $\times 10^{-10}$: | | | |
| Water | 28.58 | 7.71 | 2.89 |
| Gas | 687.50 | 185.50 | 157.70 |
| Temperature, °C. | ... | 70 | 52.2 |

Mary Estel Spring, medicinal classification, weak total mineralization or (−T), weak radio-active. This is a moderately mineralized, sodic, sulphated, alkaline-saline water, radio-activated.

Lower Spring, medicinal classification, weak total mineralization 2 or (−T2), thermic, very weak radio-active. This is a moderately mineralized, sodic, sulphated, bicarbonated, alkaline water, radio-activated.

Garage Spring, medicinal classification, weak total mineralization 2 or (−T2), thermic, very weak, radio-active. This is a moderately mineralized, sodic, sulphated, bicarbonated, alkaline water, radio-activated, carbon-dioxated.

Indian legends give proof of the fact that the red men knew of the curative properties of these waters, perhaps many centuries before the advent of the white man. The Indians brought their ill and wounded here for the benefits of the springs "Tomochici," boiling waters. During the territorial history of the section the early pioneers learned from the Indians of the wonders of the "medicine waters." It is worthy of note that the very springs which the Indians considered "medicine waters" are the very ones which are so high in radium emanations. Rheumatism, acute and chronic, neuritis and rheumatic arthritis, anemia and neurasthenia, syphilis and skin diseases, gastro-enteritis and hepatic disorders have all been helped by drinking the waters and from the use of hot radium baths. The medical profession is just beginning to appreciate the therapeutic potency of natural mineral waters charged with radio-active emanations. Radium emanations stimulate activity of the corpuscles of the blood stream, supply tone to the nervous system, stimulate gland activity and strengthen all the functions of the body.

The following springs have been used as resorts:

*Morrison Springs, P. O.*, Morrison, Jefferson County. The springs are southwest of Denver, in the Bear Creek Basin, 6000 feet above sea level. No definite information nor satisfactory analysis available; no response to correspondence.

*Artesian Magnetic Mineral Springs, P. O.*, Pueblo, Pueblo County. No definite information nor satisfactory analysis available; correspondence unanswered.

*Shaw's Magnetic Spring, P. O.*, Del Norte, Pueblo County. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

The following springs reported the commercial sale of water in 1924:

*Boulder Springs and Lithia Soda Springs, P. O.*, Salina, Boulder County.

*Green Mineral Well, P. O.*, Canon City, Fremont County.

*Horn Mineral Spring, P. O.*, Colorado Springs, El Paso County.

*Pueblo Mineral Springs, P. O.*, Pueblo, Pueblo County.

*Yampah Spring, P. O.*, Glenwood Springs, Garfield County.

## CONNECTICUT.

Connecticut extends from 41° to 42°275′ north latitude and from 70°55′ to 73°50′ west longitude, and comprises an area of 4730 square miles. The climate is marked by great extremes and sudden changes; the winters are cold and the summers very warm. The district bordering on the sea is hottest, and the northwestern portion the coldest. The mean annual temperature as observed at Hartford is about 10° C. (50° F.). The state has no lofty mountains, but in the northwestern section rise the foothills of the Berkshire Mountains, which are the southern extremities of the two great New England Ranges of the Green and the White Mountains.

Connecticut has 16 spring localities, with a total of 20 individual springs, only a few of which have been analyzed. The mineral springs of the state are comparatively unimportant, at least in number, and are not densely mineralized. They are mainly weak chalybeates, occurring as a result of the aqueous circulation over beds of bog iron ore or in connection with iron pyrites. Some of the springs are also weakly sulphuretted. Many of the springs have never been improved, few of the waters are used commercially, yet some of them have had considerable local reputation. The reputation of Stafford Springs, the only locality given by Walton, has long since transcended the limits of the state. Crook mentions only 5 localities. Many of the places once resorted to are now abandoned. The present list was secured chiefly from correspondence with spring owners and from personal investigation, and may be regarded as fairly representative of the active springs now in use.

### Althea Spring.

*(New Haven County.)*

*Postoffice,* Waterbury. *Location,* southwest of central Connecticut; southwest from Hartford, the capital city, 25 miles; north of New Haven, 20 miles; south of Bristol, 12 miles. *Situation,* on the Naugatuk River, at an elevation of about 400 feet above tide water. *Access,* via the Central Railway of New England. *Hotel,* not a resort. Waters bottled and shipped commercially. The mineralization is shown by the following analysis:

ALTHEA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 2.70 |
| Sodium chloride (NaCl) | 0.80 |
| Magnesium chloride ($MgCl_2$) | 12.90 |
| Magnesium sulphate ($MgSO_4$) | 7.40 |
| Calcium sulphate ($CaSO_4$) | 20.00 |
| Sodium nitrate ($NaNO_3$) | 36.62 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 34.40 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 5.40 |
| Silica ($SiO_2$) | 12.10 |
| Total solids | 129.32 |

This is a lightly mineralized, calcic, bicarbonated, sulphated, nitrated, alkaline-saline water; approximately 26 per cent of the salts in solution are in the form of the bicarbonate calcium, 26 per cent sodium nitrate and 21 per cent sulphate of calcium and magnesium.

### Arethusa Spring.

(*New Haven County.*)

*Postoffice*, Seymour. *Location*, southwest of central Connecticut; southwest of Hartford, the capital city, 20 miles; north of New Haven, 15 miles. *Situation*, on the Naugatuck River, at an elevation of about 40 feet above tide water. *Access*, via the New York, New Haven & Hartford Railway System and connections. *Hotel*, not a resort. Waters bottled and shipped. The mineralization is shown by the following analysis:

ARETHUSA SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst. W, W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 1.70 |
| Sodium chloride (NaCl) | 3.30 |
| Sodium sulphate ($Na_2SO_4$) | 5.45 |
| Sodium nitrate ($NaNO_3$) | 0.91 |
| Sodium bicarbonate ($NaHCO_3$) | 1.10 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 6.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 12.40 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.28 |
| Silica ($SiO_2$) | 10.30 |
| Total solids | 41.44 |

This is a very slightly mineralized, sodic, calcic, magnesic, bicarbonated, alkaline water; approximately 44 per cent of the salts in solution are in the form of the bicarbonates of calcium, magnesium, with 13 per cent of sodium sulphate. It is a remarkably pure water of very low mineralization.

### Cherry Hill Springs.

(*New Haven County.*)

*Postoffice*, Highwood. *Location*, south of Hartford, the capital city, 35 miles; north of New Haven, 5 miles; west of New London, 45 miles; east of Danbury, 30 miles. *Situation*, on the west bank of Mill River, in a low undulating region, at an elevation of 200 feet above tide water. *Access*, via the New York, New Haven & Hartford Railways. *Hotel*, not a resort. Waters bottled and shipped. The analysis shows the mineralization:

CHERRY HILL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 1.30 |
| Sodium chloride (NaCl) | 1.20 |
| Magnesium chloride ($MgCl_2$) | 3.60 |
| Magnesium sulphate ($MgSO_4$) | 3.50 |
| Calcium sulphate ($CaSO_4$) | 4.70 |
| Sodium nitrate ($NaNO_3$) | 16.65 |
| Calcium phosphate ($Ca_2[PO_4]_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 36.10 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.43 |
| Silica ($SiO_2$) | 13.80 |
| Total solids | 81.28 |

This is a lightly mineralized, calcic, bicarbonated, sodic, nitrated, alkaline-saline water; approximately 44 per cent of the salts in solution are the calcium bicarbonates and 20 per cent of sodium nitrate. This is a wholesome potable water of very slight mineralization.

## Live Oak Springs.

(*New Haven County.*)

*Postoffice*, Meridan. *Location*, south of central Connecticut; south of Hartford, the capital city, 18 miles; east of Waterbury, 12 miles; west of Middletown, 8 miles; south of New Britain, 10 miles. *Situation*, in a region of rolling hills and beautiful vales, at an elevation of about 400 feet above tide water. *Access*, via the New York, New Haven & Hartford Railway System. *Hotel*, not a resort. Waters sold commercially. See analysis herewith for the mineralization:

LIVE OAK SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 1.50 |
| Sodium chloride (NaCl) | 5.40 |
| Sodium sulphate ($Na_2SO_4$) | 13.00 |
| Magnesium sulphate ($MgSO_4$) | 4.00 |
| Sodium nitrate ($NaNO_3$) | 3.35 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 21.60 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 96.90 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.43 |
| Calcium silicate ($CaSiO_3$) | 2.30 |
| Silica ($SiO_2$) | 25.40 |
| Total solids | 173.88 |

This is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water; approximately 68 per cent of the salts in solution are the bicarbonates of calcium magnesium with smaller amounts of the sul-

sulphates of sodium and magnesium. This is a very pure, wholesome, potable water.

### Luipold Mineral Spring.

(*Fairfield County.*)

*Postoffice,* Bridgeport. *Location,* southern Connecticut; southwest of New Haven, 18 miles; south of Waterbury, 30 miles; southeast of Danbury, 22 miles; east of Ridgefield, 18 miles. *Situation,* on the tide water belt of the state at an elevation of 90 feet above sea level. *Access,* via the New York, New Haven & Hartford Railways System. *Hotel,* not run as a resort. The analysis shows the mineralization and it is rather remarkable in containing such a high percentage of the oxide of manganese, which with the iron bicarbonate combines to form a splendid blood tonic.

LUIPOLD MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, H. T. Leavenworth). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 31.60 |
| Lithium chloride (LiCl) | 28.17 |
| Potassium chloride (KCl) | 162.23 |
| Sodium chloride (NaCl) | 4622.32 |
| Sodium sulphate ($Na_2SO_4$) | 3.50 |
| Sodium bicarbonate ($NaHCO_3$) | 422.40 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 7.23 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 2347.33 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 35.16 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 19.59 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace |
| Mangano-manganic oxide ($MnO_2$) | 1511.72 |
| Aluminum oxide ($Al_2O_3$) | 9.61 |
| Silica ($SiO_2$) | 18.74 |
| Total solids | 9230.60 |

Medicinal classification, alkaline b, saline 2, manganic or (Ab, Cl 2, Mn) (analysis not complete). This is a highly mineralized, sodic, muriated, calcic, sodic, bicarbonated, alkaline-saline water, possessing diuretic, antacid, tonic and alterative properties. The water has been used successfully in the treatment of stomach disturbances due to an excess of acidity. The waters are also highly extolled in the treatment of neurasthenic affections and as a tonic in anemia, chlorosis and general debility.

### Mohican Springs.

(*Fairfield County.*)

*Postoffice,* Bridgeport. *Location,* in southern Connecticut; east of Wilton, 15 miles; south of Danbury, 22 miles; south of Waterbury, 30 miles; from Bridgeport, 5 miles. *Situation,* in the low tide water section of the state, at an elevation of 50 feet above tide water. *Access,*

via the New York, New Haven & Hartford Railways to Bridgeport, thence 5 miles, by motor, to the springs. *Hotel*, not a resort. The analysis gives the mineralization:

MOHICAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 2.10 |
| Sodium chloride (NaCl) | 4.25 |
| Sodium sulphate ($Na_2SO_4$) | 5.80 |
| Sodium nitrate ($NaNO_3$) | 0.91 |
| Sodium bicarbonate ($NaHCO_3$) | 4.70 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 7.80 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 15.00 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.28 |
| Calcium silicate ($CaSiO_3$) | 1.20 |
| Silica ($SiO_2$) | 12.00 |
| Total solids | 54.04 |

This is a very slightly mineralized, sodic, calcic, bicarbonated, alkaline water; approximately 51 per cent of the salts in solution are in the form of the bicarbonates of calcium, magnesium and sodium, with smaller amounts of the sulphate and chloride of sodium. An excellent potable water.

## Oxford Mineral Springs.

(*New Haven County.*)

*Postoffice*, Oxford. *Location*, south of central Connecticut; south of Hartford, the capital city, 20 miles. *Situation*, in a beautiful region of rolling hills and beautiful valleys. *Access*, New York, New Haven & Hartford Railways and connections. *Hotel*, very fair accommodations. The analysis shows the following mineralization:

OXFORD MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. F. Barker.) |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 5.98 |
| Potassium sulphate ($K_2SO_4$) | trace |
| Sodium sulphate ($Na_2SO_4$) | 8.37 |
| Lithium sulphate ($LiSO_4$) | trace |
| Magnesium sulphate ($MgSO_4$) | 10.60 |
| Calcium sulphate ($CaSO_4$) | 14.43 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 25.20 |
| Aluminum oxide ($Al_2O_3$) | 10.04 |
| Silica ($SiO_2$) | 22.74 |
| Total solids | 97.36 |

The analysis shows this to be a lightly mineralized, ferric, bicarbonated, alkaline-saline water, possessing diuretic, tonic and alterative

properties; practically 25 per cent of the salts in solution is the bicarbonate of iron, with 32 per cent in the form of the sulphates, sodium, magnesium and calcium.

The following springs have been used as resorts:

*North Haven Pool, R. F. D.*, New Haven, New Haven County. This place had a local reputation for more than a hundred years, but no definite information nor satisfactory analysis avilable. Correspondence unanswered.

*South Farm Mangano-chalybeate Well, P. O.*, Litchfield, Litchfield County. Inn and cottages; once a resort; no definite information nor satisfactory analysis avilable. Postmaster returns correspondence marked "unknown."

*Stafford Springs, P. O.*, Stafford Springs, Tolland County. This historic old spring began a prosperous career in 1750, and was held in high esteem throughout New England. No definite information nor satisfactory analysis available. Possibly the development of other springs with more attractions has caused this place to go into decline (innocuous desuetude).

*Stark Mineral Spring, P. O.*, Bozrah, New London County. This is one of the old springs with historical legends of the Indians recognizing the curative virtues of the waters. The place once had quite a local reputation, but no definite information nor satisfactory analysis available; correspondence unanswered.

The following springs reported the commercial sale of water in 1924:

*Bailey Natural Spring, P. O.*, Danbury, Fairfield County.
*Camp Meeting Springs, P. O.*, Milford, New Haven County.
*Crystal Spring, P. O.*, Middletown, Middlesex County.
*Crystal Spring, P. O.*, Derby, New Haven County.
*East Hill Spring, P. O.*, Ansonia, New Haven County.
*Elco Springs, P. O.*, Bristol, Hartford County.
*Granite Rock Springs, P. O.*, Haddam, Middlesex County.
*Gra Rock Spring, P. O.*, Canton, Hartford County.
*Hillside Spring, P. O.*, Meriden, New Haven County.
*Hosmer Mountain Spring, P. O.*, Windham, Windham County.
*Pequot Spring, P. O.*, Glastonbury, Hartford County.
*Richardson Spring, P. O.*, Torrington, Litchfield County.
*Rockledge Spring, P. O.*, New Haven, New Haven County.
*Rock Spring, P. O.*, Fairfield, Fairfield County.
*Silver Rock Spring, P. O.*, Middletown, Middlesex County.
*Stafford Springs, P. O.*, Stafford, Tolland County.
*Veruna Spring, P. O.*, Stamford, Fairfield County.

## DELAWARE.

Delaware extends from 38°28′ to 39°50′ north latitude, and from 75°2′ to 75°47′ west longitude, and comprises an area of 2050 square

miles, of which 90 square miles is water surface. The length of the state is about 100 miles and the greatest width is about 100 miles and the least width is 15 miles. The climate is mild, the mean annual temperature being about 11.5° C. (53° F.). The northern portion is much colder and more healthful than the southern. The surface of the northern portion is diversified by hill and dale, while the southern section is almost dead level.

Delaware has, according to Peale's list, 5 spring localities, with a total of 5 individual springs, none of which seems to have been satisfactorily analyzed. From the few geological reports extant, we observe that chalybeate springs are found within the borders of this little state. They are, however, of comparatively little importance, only 1, so far as learned, having been utilized as a place of resort, the Brandywine Chalybeate Spring, which has long since been abandoned. A careful search through all the available literature pertaining to mineral springs, supplemented by considerable correspondence, has failed to furnish information of any locality used at the present time as a resort. Bulletins of the U. S. Geological Survey as late as 1923 do not show any locality reporting sales of mineral water.

## DISTRICT OF COLUMBIA.

The District of Columbia comprises an area of 60 square miles, situated on the east bank of the Potomac River. The surface is flat and marshy along the Potomac, but elsewhere gently rolling and hilly. The climate is mild and equable, the mean annual temperature being about 13.3° C. (56° F.). The northern section is much colder and more healthful than the southern. Rock Creek traverses the District and empties into the Potomac; the scenery along this creek is picturesque and inviting.

The District, according to Peale's list, contains 2 spring localities, with a total of 4 individual springs, none of which have been analyzed. The few springs reported are said to be chalybeate, but none of them, even the strongest, is of any importance. At Uniontown, opposite Washington, and also near Chevy Chase, chalybeate springs are found. There are also within the city limits springs or wells said to be mineralized.

## FLORIDA.

Florida extends from 24°30′ to 31° north latitude, and from 79°48′ to 87°38′ east longitude, and comprises a total area of 58,680 square miles, of which 4440 square miles are covered by rivers and lakes. The most remarkable feature of this immense area is the Everglades, a marshy formation filled with islands. The surface of the state is generally level, the greatest elevation being not more than 300 feet above sea level. The climate is subtropical, the average summer temperature being 26.7° C. (80° F.) and the winter varying from 18.5° to 21.1° C. (65° to 70° F.), according to location. The mild equable

climate of the winter months has of late years attracted the attention of the well-to-do in the colder sections of the north and Florida has become the "playground," as it were, for the nation. The climate may be said to be subtropical; frosts are rarely seen, therefore vegetation is varied and abundant; tropical and subtropical fruits and flowers flourish luxuriantly.

Florida has 37 spring localities, with a total of 58 individual springs, 20 of which have been analyzed and 11 used as places of resort. The springs of Florida are remarkable for their great size rather than for the quantity of mineral matter they contain. Some of the streams issuing from them are large enough to float steamboats. One spring in Marion County has a flow of 5,550,000 gallons per hour, and a number of others have a flow exceeding 1,000,000 gallons per hour. The majority of the springs in the eastern and southern sections of this state are classified as weak sulphur waters. In the northeastern portion of the state they appear to be more frequently chalybeate. A majority of the springs are thermal, since they doubtless exceed the surrounding atmosphere in the immediate locality. The temperature of the Florida springs are remarkably uniform summer and winter. They are used principally as winter resorts, and with few exceptions the waters are not used commercially. The list given herewith has been secured mainly from personal observation and from correspondence with spring owners, and largely through the courtesy of Mr. Herman Gunter, state geologist, to whom the author acknowledges his appreciation.

## Benson Mineral Springs.

(*Volusia County.*)

*Postoffice,* Enterprise. *Location,* in eastern Florida; south of Jacksonville, 105 miles; north of Orlando, 25 miles. *Situation*, near the east coast of Florida, on a small stream running north; the elevation above tide water is about 26 feet. The surroundings are semitropical in flora and fauna. *Access,* via the Atlantic Coast Line Railway. *Hotel,* good hotel accommodations. The waters on analysis reveal the following mineralization:

BENSON MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. Hollenshead). |
|---|---|
| Sodium chloride ($NaCl$) | 4504.371 |
| Magnesium chloride ($MgCl_2$) | 819.787 |
| Calcium chloride ($CaCl_2$) | 76.701 |
| Ferrous chloride ($Fe_2Cl_6$) | 1.594 |
| Sodium bromide ($NaBr$) | 133.722 |
| Potassium sulphate ($K_2SO_4$) | 60.346 |
| Calcium sulphate ($CaSO_4$) | 720.043 |
| Sodium phosphate ($Na_2HPO_4$) | 0.994 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 330.928 |
| Silica ($SiO_2$) | 16.988 |
| Total solids | 6705.474 |
| Gases: | |
| Carbon dioxide, parts per 1,000,000 | 379.624 |
| Hydrogen sulphide present | |

Medicinal classification, saline 3, weak calcic sulphate 2 or (Cl 3, —CaS2), sulphuretted. The analysis shows this to be a moderately highly mineralized, sodic, magnesic, calcic, muriated and calcic and potassic sulphated saline (bromic) water, sulphuretted, possessing diuretic, laxative and tonic properties.

### Crystal Mineral Water Springs.

(*Duval County.*)

*Postoffice,* White House. *Location,* in the northeastern portion of the state; east of Tallahassee, the capital city, 160 miles; north of Tampa, 190 miles. *Situation,* on the upper border of "trail ridge," a beautiful picturesque region with an elevation of about 84 feet above tide water. *Access,* via Seaboard Air Line Railway and the splendid graded macadam highways. *Hotel,* no accommodations for guests. The spring has a bold flow and the analysis herewith shows the mineralization:

CRYSTAL MINERAL WATER SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, L. Y. Dyrenforth). |
|---|---|
| Potassium chloride (KCl) | trace |
| Sodium chloride (NaCl) | 27.13 |
| Sodium sulphate ($Na_2SO_4$) | 3.04 |
| Calcium phosphate ($Ca_2[PO_4]_3$) | 7.25 |
| Sodium nitrate ($NaNO_3$) | 0.07 |
| Aluminum bicarbonate ($Al_2[HCO_3]_3$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 13.62 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 77.48 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 317.53 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 26.66 |
| Silica ($SiO_2$) | 28.93 |
| Total solids | 501.71 |
| Flow in gallons per day | 10,000 |

Medicinal classification, weak mineralized or (—T). This is a moderately mineralized, calcic, magnesic, ferruginous, bicarbonated alkaline (phosphatic) water, possessing diuretic, antacid and tonic properties. This water is highly endorsed by the profession in bladder, kidney and stomach disorders, and the iron content makes it a valuable tonic in anemia, chlorosis and general debilitated states and in all depraved conditions of the blood and blood-making organs. The waters are bottled and sold commercially throughout Florida and adjoining states.

### Deleon Springs.

(*Volusia County.*)

*Postoffice,* Deleon Springs. *Location,* in eastern Florida; south of Jacksonville, 90 miles; north of Orlando, 45 miles; south of St. Agus-

tine, 60 miles; north of Deleon, 10 miles. *Situation*, on a small stream, running north to join St. John's River. The elevation is about 28 feet above tide water. *Access*, via the Atlantic Coast Line Railway. *Hotel*, fair accommodations and conveniences. The springs are well known. The analysis below shows the mineralization.

DELEON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Florida Geological Survey). |
|---|---|
| Sodium chloride ($NaCl$) | 843.00 |
| Magnesium chloride ($MgCl_2$) | 149.00 |
| Magnesium sulphate ($MgSO_4$) | 30.00 |
| Calcium sulphate ($CaSO_4$) | 98.00 |
| Sodium nitrate ($NaNO_3$) | 1.40 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 157.00 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.48 |
| Silica ($SiO_2$) | 19.00 |
| Total solids | 1256.88 |

Medicinal classification, weak saline 3 or (−Cl 3). This is a moderately mineralized, sodic, magnesic, muriated, calcic, sulphated and bicarbonated saline water, sulphuretted, possessing diuretic and antacid properties. These waters are very popular with local physicians and extensively used medicinally.

## Espirito Santo Springs.

(*Pinellas County.*)

*Postoffice*, Safety Harbor. *Location*, on the coast of western Florida, facing the Gulf of Mexico; north of St. Petersburg, 31 miles; west of Tampa, 25 miles. *Situation*, near the north end of Tampa Bay, at an elevation of about 25 feet above sea level. *Access*, via the Seaboard Air Line Railway, thence only a short ½ mile to the springs. *Hotel*, there is in course of construction a hotel, sanitarium and bathing establishment. The sanitarium and bathing establishment already erected are both modern in construction and equipment, with every appointment for the scientific application of all the branches of physiotherapy, where guests may enjoy the full benefit of the science of hydrotherpy and balneotherapy under the supervision of an expert in hydriatics. The Springs Espirito Santo (meaning Springs of the Holy Spirit), so named by Hernando De Soto when he discovered them, Sunday, May 18, 1593, have had an interesting historical career. The analysis herewith shows the mineralization:

ESPIRITO SANTO SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. H. Pratt). | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Sodium chloride (NaCl) | 1394.00 | 2542.03 | 1324.41 | 1230.65 |
| Magnesium chloride (MgCl) | ... | 178.60 | 73.19 | 88.79 |
| Calcium chloride ($CaCl_2$) | 231.05 | 84.84 | 129.58 | 122.55 |
| Calcium sulphate ($CaSO_4$) | 174.49 | 307.49 | 164.89 | 140.96 |
| Sodium bicarbonate ($NaHCO_3$) | 32.77 | | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 364.50 | 90.52 | 224.62 | 148.55 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | ... | 228.51 | 148.55 | 148.55 |
| Magnesium oxide (MgO) | 92.56 | | | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 8.57 | trace | trace | trace |
| Silica ($SiO_2$) | 18.85 | 1.89 | 17.14 | 15.43 |
| Organic matter | ... | ... | 6.86 | 15.43 |
| Total solids | 2316.79 | 3433.88 | 2089.24 | 1895.48 |

Spring No. 1, medicinal classification, weak alkaline b, weak saline 4 or (−Ab, −Cl 4).

Spring No. 2, medicinal classification, saline 1.5 or (Cl 1.5).

Spring No. 3, medicinal classification, weak alkaline b, weak saline 4 or (−Ab, −Cl 4).

Spring No. 4, medicinal classification, weak saline 4 or (−Cl 4).

A study of the analyses of the 4 springs reveals a close similarity of of percentage proportions of the predominating chemical constituents of the four waters, so that they can all be classed as moderately highly mineralized, sodic, calcic, muriated, magnesic, bicarbonated, saline water, possessing diuretic, antacid and eliminative properties. The waters are highly endorsed by the profession who are acquainted with the therapeutic virtues of the waters. The waters have been used with success in the treatment of rheumatism and arthritic joint disorders. In catarrhal disorders of the intestinal tract and in diseases of the liver and biliary passages.

## FLAMINGO MINERAL SPRINGS.

*(Volusia County.)*

*Postoffice*, Orange City. *Location*, on the eastern border of the state; north of Orlando, 30 miles; south from Jacksonville, about 100 miles. *Situation*, in the outskirts of Orange City, 1 mile west, amid the orange-scented orchards of this beautiful section of the state. *Access*, via Orange City Station on the Florida & East Coast Railway, thence 1 mile by motor to the springs. *Hotel*, no accommodations for guests, except in Orange City, where comfortable hotels may be found. The waters are bottled and sold commercially all over the state. The analysis given below shows the mineralization:

FLAMINGO MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). |
|---|---|
| Sodium chloride (NaCl) | 12.2 |
| Magnesium sulphate ($MgSO_4$) | 11.8 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 16.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 163.6 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 7.9 |
| Total solids | 211.5 |

This is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water, possessing diuretic and antacid properties; a sanitarily pure, wholesome, potable water. It has an extensive distribution all over the state, flowing at the rate of 500,000 gallons daily. The waters are bottled under the most sanitary conditions in a modern up-to-date bottling plant.

## Green Cove Springs.

(*Clay County.*)

*Postoffice,* Green Cove Springs. *Location,* in northeastern Florida; south of Jacksonville, 32 miles; east of Tallahassee, the capital city, 170 miles; north of Palatka, 22 miles. *Situation,* on the west bank of the St. John River, at an altitude of 28 feet above sea level. *Access,* via the Atlantic Coast Line Railway. *Hotels,* there are good hotels in Green Cove Springs, with modern appointments and conveniences. The springs (well) is 815 feet deep, 4 inches in diameter and has a "head" of water 23 feet above the surface. The elevation of the well is 24 feet above the surface of St. John's River. The analysis shows the mineralization:

GREEN COVE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Florida Geological Survey). |
|---|---|
| Potassium chloride (KCl) | 3.4 |
| Sodium chloride (NaCl) | 6.1 |
| Magnesium chloride ($MgCl_2$) | 0.5 |
| Calcium chloride ($CaCl_2$) | |
| Sodium sulphate ($Na_2SO_4$) | |
| Magnesium sulphate ($MgSO_4$) | 61.0 |
| Calcium sulphate ($CaSO_4$) | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 21.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 112.0 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.1 |
| Silica ($SiO_2$) | 13.2 |
| Total solids | 207.3 |
| Gases, hydrogen sulphide present. | |

The analysis shows this to be lightly mineralized, calcic, magnesic, bicarbonated, sulphated, alkaline water, sulphuretted, possessing diuretic antacid and alterative properties, and valuable in the treatment of gastric irritation due to acidity, etc. This water has become very popular in the treatment of debility and general run-down conditions. It has the endorsement of local physicians.

## Magnolia Springs.

(*Clay County.*)

*Postoffice*, Magnolia Springs. *Location*, in northeastern Florida; south of Jacksonville, 31 miles; east of Tallahassee, the capital city, 170 miles; north of Palatka, 23 miles. *Situation*, on the west bank of the St. John's River, at an altitude of about 30 feet above tide water. *Access*, via the Atlantic Coast Line Railway. *Hotel*, there is a modern resort hostelry. The spring (well) is said to be 325 feet deep and overflows at the surface. The water is bottled, shipped and sold commercially. The analysis herewith shows the mineralization:

MAGNOLIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Florida Geological Survey). |
|---|---|
| Sodium chloride ($NaCl$) | 21.00 |
| Magnesium chloride ($MgCl_2$) | 5.16 |
| Calcium chloride ($CaCl_2$) | 8.30 |
| Calcium sulphate ($CaSO_4$) | 7.10 |
| Sodium nitrate ($NaNO_3$) | 36.00 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.35 |
| Silica ($SiO_2$) | 3.20 |
| Total solids | 81.05 |

This is a lightly mineralized, sodic, nitrated, muriated, saline water, possessing diuretic and slight tonic properties. From its purity and low mineralization it should be a delightful, potable water.

## Pipkin Mineral Wells.

(*Pinellas County.*)

*Postoffice*, Safety Harbor. *Location*, on the west coast of the state, facing the Gulf of Mexico; north of St. Petersburg, 31 miles; west of Tampa, 25 miles; south of Tarpon Springs, 32 miles. *Situation*, in a very attractive spot in this quaint little village, facing the Gulf of Mexico. *Access*, via depot on main line of the Seaboard Air Line Railway, ½ mile from the spring. *Hotel*, with 25 rooms and an annex with 25 more; good service and comfortable accommodations. All year round resort, with a bathing establishment for the balneological accommodations of guests. The water on analysis shows the following mineralization:

PIPKIN MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, M. Pipkin). |
|---|---|
| Sodium chloride ($NaCl$) | 21,703.86 |
| Magnesium chloride ($MgCl_2$) | 3,094.08 |
| Potassium sulphate ($K_2SO_4$) | 352.17 |
| Calcium sulphate ($CaSO_4$) | 2,796.34 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 572.97 |
| Aluminum oxide ($Al_2O_3$) | 13.00 |
| Silica ($SiO_2$) | 6.00 |
| Total solids | 28,538.42 |

Medicinal classification, strong saline 2.5, calcic sulphate 1.5 or (+Cl 2.5, CaS1.5). This is a very highly mineralized, sodic, magnesic, muriated, saline water, carbon-dioxated, possessing diuretic and aperient properties. It is said to be very efficacious in constipation. The waters have some local reputation as a palliative agent in rheumatic, gastric and liver troubles. The waters have been bottled and sold commercially for the past several years.

### Suwanee Sulphur Springs.

(*Suwanee County.*)

*Postoffice*, Suwanee. *Location*, in the northern portion of the state; west of Jacksonville, 80 miles; east of Tallahassee, the capital city, 90 miles; north of Tampa, 175 miles. *Situation*, in a beautiful 100-acre park, on a picturesque bluff, wooded with sturdy live oaks and stately pine, 150 feet above sea level, overlooking the historic Suwanee River. *Access*, via Suwanee Station on the Atlantic Coast Line Railway, thence by motor 1 mile to the springs, or via the splendid highways, leading all over this section of the state. *Hotel*, this is a modern resort hostelry. In addition, there are a number of comfortable cottages for those who desire privacy and seclusion. The water from the springs is piped throughout the hotel and cottages and supplied either hot or cold direct from the fountains. Modern bathing accommodations are provided in a well-equipped bath-house for the administration of the Suwanee sulphur baths. The analysis below shows the mineralization of the water:

SUWANEE SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, M. D. Foster).[1] |
|---|---|
| Sodium chloride (NaCl) | 11.00 |
| Potassium chloride (KCl) | 1.10 |
| Sodium sulphate ($Na_2SO_4$) | 4.00 |
| Magnesium sulphate ($MgSO_4$) | 30.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 35.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 211.00 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.51 |
| Silica ($SiO_2$) | 14.00 |
| Total solids | 220.00 |
| Temperature, °C. | 23.3 |
| Flow, gallons in twenty-four hours | 1,080,000 |
| Gas: | |
| Sulphuretted hydrogen abundant. | |

[1] Recalculated from analysis by the United States Geological Survey.

Medicinal classification, sulphuretted. This is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water, sulphuretted. The water as it issues from the spring exhales a strong, sulphurous odor, due to the sulphuretted hydrogen gas with which it is heavily

charged and to which is due much of its therapeutic virtue. Rheumatism, nervous disorders, diseases of the gastro-intestinal tract, liver and gall ducts are benefited by the waters and baths. The slight bicarbonate of iron contained in this water imparts to it tonic properties indicated in all depleted conditions of the blood and blood-making organs.

### Wekiwa Springs.

(*Orange County.*)

*Postoffice,* Apopka. *Location,* near the center of the state; north of Orlando, 18 miles; south of Palatka, 75 miles; northeast of Tampa, 80 miles. *Situation,* in Wekiwa Springs Park. The springs have such an enormous flow that the waters spread out and form Wekiwa Lake. Wekiwa Park is beautifully adorned with native black oak, pine, palm and live oak festooned with gray hanging moss. Semitropical fruit and magnolias add to the natural beauty of the surroundings. *Access,* via the Apopka Station, on Atlantic Coast Line and the Seaboard Air Line Railways. *Hotel,* a small hotel at present, but a much larger establishment is planned for early construction. The waters from these springs, 4 in number are highly endorsed by the profession. The following analysis shows the mineralization:

WEKIWA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Geological Survey). |
|---|---|
| Sodium (potassium) chloride (Na[K]Cl) | 9.60 |
| Sodium sulphate ($Na_2SO_4$) | 3.40 |
| Magnesium sulphate ($MgSO_4$) | 3.60 |
| Potassium nitrate ($KNO_3$) | 0.33 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 49.80 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 117.50 |
| Ferric oxide ($Fe_2O_3$) | 0.07 |
| Aluminum oxide ($Al_2O_3$) | 0.57 |
| Silica ($SiO_3$) | 11.00 |
| Total solids | 195.87 |

The analysis shows this to be a lightly mineralized, magnesic, calcic, bicarbonated, alkaline (ferruginous) water, possessing diuretic and antacid properties. The water is said to be of value in treatment of a variety of stomach, bladder and kidney affections, where a water of this type is indicated. The springs have on file a large number of favorable endorsements by the profession of the curative efficiency of this water. The water is bottled and shipped extensively.

### White Springs.

(*Hamilton Springs.*)

*Postoffice,* White Springs. *Location,* on the northern border of the state; west of Jacksonville, 75 miles; south of Valdosta, Ga., 52 miles.

*Situation*, on the banks of the old historic Suwanee River, famous in song and story of the "Old South." The elevation is 125 feet above sea level. *Access*, on the main line of the Georgia, Southern & Florida Railway, with through trains from Chicago and the North; also via motor busses which ply between the important cities in lower Georgia and Florida. *Hotels*, there are four good hotels offering accommodations throughout the year. There is a modern bathing establishment, with up-to-date equipment. The water of the White Springs flows at the rate of 32,460 gallons per hour. The analysis below shows the mineralization:

WHITE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, M. D. Foster).[1] |
|---|---|
| Potassium chloride (KCl) | none |
| Sodium chloride (NaCl) | 13.00 |
| Calcium chloride ($CaCl_2$) | none |
| Magnesium chloride ($MgCl_2$) | none |
| Sodium sulphate ($Na_2SO_4$) | 1.80 |
| Magnesium sulphate ($MgSO_4$) | 22.00 |
| Calcium sulphate ($CaSO_4$) | none |
| Sodium nitrate ($NaNO_3$) | none |
| Sodium bicarbonate ($NaHCO_3$) | none |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 51.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 172.00 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.67 |
| Silica ($SiO_2$) | 17.00 |
| Total solids | 203.00 |
| Temperature, °C. | 22.2 |
| Radio-activity, mc. per liter of water | 0.98 |
| Flow in gallons per day | 32,460 |

[1] Calculated from analysis made by United States Geological Survey.

This water is said to contain liberal quantities of hydrogen sulphide gas and carbonic anhydride and free oxygen and nitrogen.

This spring is a lightly mineralized, calcic and magnesic bicarbonated alkaline water, sulphuretted, radio-activated, possessing diuretic, antacid and radio-active properties. This water has been used with success in the treatment of rheumatism, sciatica, neuritis and arthritis and in disturbances of the gastro-intestinal tract and in diseases of the bladder and kidneys. According to the U. S. Geological Survey this is one of the largest flowing springs in the world. The atmosphere for some distance from the springs is surcharged with the odor of the natural hydrogen sulphide gas, so much so that mosquitoes and other winged pests are unknown. The waters are very highly radio-active, which adds to its therapeutic potency and medicinal usefulness.

The following springs were once used as resorts:

*Blue Springs, P. O.*, Orange City, Volusia County. Unimproved, but has some local reputation. No definite information nor satisfactory analysis available.

*Newport Sulphur Springs, P. O.*, St. Marks, Wakulla County. No definite information nor satisfactory analysis available; correspondence unanswered.

*Orange Springs, P. O.*, Orange Springs, Monroe County. A saline, sulphuretted water, flowing 5,055,000 gallons hourly, but no definite information nor satisfactory analysis available; correspondence unanswered.

*Su-No-Wa Springs, P. O.*, Verdie, Nassau County. The information is not satisfactory, nor the analysis in proper shape. Repeated correspondence failed to secure the needed information.

The following springs reported the commercial sale of water in 1924:

*Brack's Get Well Spring, P. O.*, Bradentown, Manatee County.

*Crystal Springs, P. O.*, Crystal Springs, Pasco County.

*Deep Rock Spring, P. O.*, West Palm Beach, Palm Beach County.

*Egret Springs, P. O.*, Fort Pierce, St. Lucie County.

*Good Hope Mineral Spring, P. O.*, Jacksonville, Duval County.

*Gra Rock Well, P. O.*, Miami, Dade County.

*Hampton Springs, P. O.*, Hampton Springs, Taylor County.

*Heilbronn Spring, P. O.*, Starke, Bradford County.

*Peerless Spring, P. O.*, Miami, Dade County.

*Purity Spring, P. O.*, Tampa, Hillsborough County.

*Saint Nicholas Mineral Springs, P. O.*, South Hacksonville, Duval County.

*Su-No-Wa Spring, P. O.*, Bryceville, Nassau County.

*Wi-Wauchula Spring, P. O.*, Jacksonville, Duval County.

## GEORGIA.

Georgia extends from 30°5′ to 35° north latitude and from 81°5′ to 85°5′ west longitude, and comprises an area of 58,000 square miles, of which about 500 square miles are covered by water. Spurs of the Blue Ridge and Alleghany Mountains reach down into the northwestern section of the state; from thence the surface gradually slopes to the southeast, where the great Okefinokee Swamp begins, and extends into Florida. This swamp covers an area about 40 miles long by 30 miles wide. The climate of Georgia shows a wide range between the mountainous section, where the temperature falls below 4.4° C. (40° F.) and in the extreme South, where the average reaches 21.1° C. (70° F.). In southern Georgia the climate resembles that of Florida; the winters are mild, with slight frosts, and snow is rarely seen; the summers are long and hot. The northern part has a salubrious climate, the winters and summers being free from extremes. The mean temperatures for the year are as follows: Atlanta, 16° C. (61° F.); Augusta, 17.8° C. (64° F.); Athens, 17.5° C. (63° F.); Americus, 20° C. (68° F.); Brunswick, 21.1° C. (69° F.); Savannah, 19.5° C. (67.36° F.).

Georgia has 55 spring localities, with a total of 290 individual

springs, the majority of which have recently been analyzed by the State Geological Survey, and a number used as resorts, while several are used commercially. It will be seen that the mineral springs of Georgia are quite numerous, and some of them are of considerable importance. The majority of the springs fall into the class of chalybeate and sulphuretted waters. The best description of the mineral springs of Georgia is contained in *Bulletin* No. 20, issued by the State Geological Survey, listing all the important springs of the state; Crooks, in his work, lists 32 localities. The lists given herewith have been secured largely through the courtesy of S. W. McCallie, State Geologist, through personal investigation, from Peale's list and from other published works, and, while not complete, yet it fairly represents the number in active use at the present time.

### Artesian Lithia, Louch, Medlock and Sulpho-magnesia Wells.

(*Cobb County.*)

*Postoffice*, Austel. *Location*, in northern Georgia; west of Atlanta, the capital city, 17 miles; northwest of Savannah, 200 miles. *Situation*, in a rough and rugged, broken, hilly country, at an elevation of 1200 feet above sea level. *Access*, via the Southern Railway and the Louisville & Nashville Railway, thence only a short distance to any of the wells. *Hotels*, the hotels in Austel offer good accommodations.

The Artesian Well is situated on the bank of Sweet Water Creek, $\frac{3}{4}$ mile northwest of Austel. The well is 2 inches in diameter and 900 feet deep.

The Medlock Well, known as "Old Salt," is near the left bank of Sweet Water Creek, $\frac{5}{8}$ mile northwest of Austel. The well is 6 inches in diameter and 65 feet deep.

The Louch Well is situated on the left bank of Sweet Water Creek, within 75 yards of the Medlock Well. The well is 6 inches in diameter and 80 feet deep.

The Sulpho-magnesia Artesian Well is situated on Sweet Water Creek $\frac{3}{4}$ mile northwest of Austel and only a short distance from the Artesian Lithia Well. The well is 2 inches in diameter and 750 feet deep. The analyses on page 323 show the mineralization:

The Artesian Lithia Well, medicinal classification, weak saline 4 or (−Cl 4). This is a moderately highly mineralized, sodic, lithic, muriated and calcic carbonated and sulphated saline water, possessing diuretic, antacid and slight laxative properties. This water should be used in the treatment of intestinal stasis, constipation and in hepatic and renal disorder.

The Medlock Well, medicinal classification, saline 4 or (Cl 4). This is a highly mineralized, sodic, calcic, potassic, lithic, muriated and calcic sulphated saline water, possessing diuretic, slight laxative and tonic properties. This water has achieved some reputation in the treatment of diseases of the stomach, bowels, liver and kidneys.

ARTESIAN LITHIA, MEDLOCK, LOUCH AND SULPHO-MAGNESIA WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). | | | |
|---|---|---|---|---|
| | Artesian Well. | Medlock Well. | Louch Well. | Sulpho-magnesia Well. |
| Lithium chloride (LiCl) | 47.00 | 41.86 | 24.67 | 7.20 |
| Potassium chloride (KCl) | ... | 122.80 | 119.50 | 3.74 |
| Sodium chloride (NaCl) | 1634.30 | 7093.80 | 5070.90 | |
| Calcium chloride ($CaCl_2$) | ... | 634.40 | | |
| Potassium bromide (KBr) | 16.20 | ... | 4.20 | trace |
| Sodium bromide (NaBr) | 4.00 | | | |
| Sodium sulphate ($Na_2SO_4$) | 21.10 | | | |
| Potassium sulphate ($K_2SO_4$) | ... | ... | ... | 5.07 |
| Magnesium sulphate ($MgSO_4$) | 64.20 | ... | 133.30 | |
| Calcium sulphate ($CaSO_4$) | 153.20 | 787.40 | 670.80 | |
| Aluminum sulphate ($Al_2[SO_4]_2$) | 3.90 | ... | 1.36 | 5.45 |
| Barium sulphate ($BaSO_4$) | ... | ... | 0.38 | |
| Sodium phosphate ($Na_2HPO_4$) | 0.80 | 0.20 | trace | 0.66 |
| Sodium arsenite ($Na_2HAsO_4$) | ... | ... | ... | trace |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | ... | 40.09 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 433.50 | ... | 20.41 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 306.66 | 65.93 | ... | 101.25 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.46 | ... | 1.97 | 4.23 |
| Manganese bicarbonate $Mn[HCO_3]_2$) | ... | ... | trace | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | ... | 18.40 | | |
| Silica ($SiO_2$) | 24.30 | 26.20 | 11.60 | 18.00 |
| Total solids | 2277.12 | 9224.49 | 5748.68 | 206.10 |

The Louch Well, medicinal classification, saline 3 or (Cl 3). This is a moderately highly mineralized, sodic, potassic and lithic muriated and calcic magnesia sulphated saline water, possessing diuretic, tonic and alterative properties, valuable in the treatment of stomach and bowel disorders, intestinal stasis and constipation, bladder and kidney affections.

The Sulpho-magnesia Artesian Well is a lightly mineralized, calcic and sodic bicarbonated, alkaline water, possessing diuretic and ant-acid properties and of use in kidney and bladder trouble. The waters from all these wells are rather remarkable on account of the high sodium chloride content and the high lithium content as well. This is more interesting when we take into consideration the geological formation; the water in each instance comes from granite gneiss and all the rock for miles around is highly crystalline.

## Beall Spring.

(*Warren County.*)

*Postoffice,* Warrenton. *Location,* midwestern Georgia; west of Augusta, 40 miles; southwest of Atlanta, the capital city, 100 miles;

north of Dublin, 70 miles. *Situation*, in an undulating Savanna-like region, on an eminence, at an elevation of about 500 feet above sea level. *Access*, via Southern Railway to Warrenton, thence by motor 8 miles to the springs or to Mitchel, a station on the same railroad. *Hotel*, there is a small hotel with some conveniences. There were crude attempts at entertaining guests here as early as 1825, and for many years had quite a reputation as a resort. The water on analysis reveals the following mineralization:

BEALL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). |
|---|---|
| Potassium chloride (KCl) | 3.30 |
| Sodium chloride (NaCl) | 6.20 |
| Sodium sulphate ($Na_2SO_4$) | 18.60 |
| Sodium bicarbonate ($Na[HCO_3]_2$) | 2.43 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 148.39 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 15.39 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.27 |
| Aluminum oxide ($Al_2O_3$) | 2.59 |
| Silica ($SiO_2$) | 64.00 |
| Total solids | 264.17 |
| Gases: | |
| Carbon dioxide (free) | 107.00 |

The analysis shows this to be a lightly mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic antacid and slight tonic and alterative properties. The waters have been used with success in the treatment of indigestion due to acidity and in irritation of the bladder and kidneys. The waters are highly charged with natural carbonic acid gas which imparts to the water valuable medicinal properties, especially when drunk at the springs.

## Bowden Lithia Springs.

(*Fulton County.*)

*Postoffice*, Lithia Springs via Austel. *Location*, in northern Georgia; west of Atlanta, the capital city, 17 miles; southwest of Chattanooga. *Situation*, in a rough, rugged, broken, hilly country, at an elevation of 1200 feet above sea level. Nearby is Dome Rock and Chapel Hill, mute evidences of the mighty action of some great sea which surged and roared here in prehistoric days. *Access*, via the Southern Railway; the Piedmont Airline Railway; the Louisville & Nashville Railway; via motor of the great national highways. *Hotel*, the old hotel was burned some years ago and at present good accommodations can be had at Austel only a short walk from the springs. Prior to the coming of the white man, the Cherokee Indians knew of these springs, and called them "deer lick," on account of these animals frequenting

the springs to lick the rocks to obtain salt. Some years ago an effort was made to increase the flow of water by blasting. The undertaking was well nigh ruinous. The blasting unloosed a stream of fresh freestone water, which changed the chemical composition of the spring. These springs are perhaps the most important mineral waters in Georgia, as shown by the following analyses:

BOWDEN LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). Spring No. 1. | Spring No. 2. |
|---|---|---|
| Lithium chloride (LiCl) | 34.00 | 25.20 |
| Potassium chloride (KCl) | 0.30 | |
| Sodium chloride (NaCl) | 1785.00 | 922.30 |
| Potassium bromide (KBr) | 30.80 | 20.80 |
| Sodium sulphate ($Na_2SO_4$) | 0.30 | 40.80 |
| Magnesium sulphate ($MgSO_4$) | 45.90 | 34.50 |
| Calcium sulphate ($CaSO_4$) | 183.90 | 68.00 |
| Barium sulphate ($BaSO_4$) | 0.30 | |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 10.90 | 1.20 |
| Sodium phosphate ($Na_2HPO_4$) | 0.80 | |
| Sodium arsenate ($Na_2HAsO_4$) | 0.40 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 0.81 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 253.69 | 276.53 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 7.34 | 1.13 |
| Silica ($SiO_2$) | 32.60 | 48.20 |
| Total solids | 2387.04 | 1440.66 |
| Gases | | |
| Carbon dioxide (free) ($CO_2$) | 70.90 | 77.30 |
| Flow in gallons per day | 4320 | 4000 |

Spring No. 1, medicinal classification, saline or (Cl). This is a moderately highly mineralized, sodic muriated, calcic sulphated saline water, carbon-dioxated, possessing diuretic antilithic solvent and tonic properties.

Spring No. 2, medicinal classification, weak saline 2 or (−Cl 2). This is a moderately highly mineralized, sodic, muriated saline (bromic) water, carbon-dioxated, possessing diuretic, antilithic, solvent and tonic properties. These waters are highly endorsed by the profession in the treatment of kidney and bladder troubles, calculi, gravel and vesical catarrh. Externally applied in baths, the waters are said to possess curative value in chronic ulcer, glandular enlargements, etc. The waters are bottled and shipped commercially.

## Cascade Springs.

(*Fulton County.*)

*Postoffice,* R. F. D. No. 1, Atlanta. *Location,* on Cascade Avenue; southeast of Atlanta, the capital city, 6 miles; northwest of Macon, 120 miles; west of Augusta, about 200 miles. *Situation,* in a deep,

rocky gulch, near a beautiful waterfall, from whence it takes its name. The springs rise from igneous rocks near a small stream which flows through this ravine. *Access*, via Atlanta Depot, which is the greatest railroad center in the state, thence by motor 6 miles to the spring, over a graded concrete highway. *Hotel*, on a high hilltop, near the springs, overlooking the surrounding country, is a well-arranged modern hotel and a number of comfortable cottages. The climate is mild and equable, not too hot and never too cold. Summer resort only. The springs, 2 in number, located not far apart, flow from the solid rocks, and the analysis shows the following mineralization:

CASCADE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). | |
|---|---|---|
| | Spring No. 1. | Spring No. 2. |
| Sodium chloride (NaCl) | 3.50 | 2.50 |
| Potassium chloride (KCl) | 6.30 | 5.70 |
| Sodium sulphate ($Na_2SO_4$) | 9.94 | 6.50 |
| Sodium phosphate ($Na_2HPO_4$) | 0.20 | |
| Sodium bicarbonate ($NaHCO_3$) | 5.72 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 14.17 | 21.05 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 9.50 | 16.19 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 3.73 |
| Ferric oxide ($Fe_2O_3$) | 0.70 | |
| Aluminum oxide ($Al_2O_3$) | 0.80 | 0.70 |
| Silica ($SiO_2$) | 22.50 | 20.00 |
| Total solids | 73.33 | 76.37 |
| Gases at 0° C., 760 mm. pressure ($CO_2$), cc. per liter | 49.90 | 36.00 |

Spring No. 1 is a slightly mineralized, sodic, calcic, bicarbonated alkaline water, carbon-dioxated, possessing antacid and diuretic properties.

Spring No. 2 is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water, carbon-dioxated, possessing antacid and diuretic properties.

The water from Spring No. 2 is highly endorsed by physicians in bladder and kidney irritations and in some of the milder forms of gastric troubles due to hyperacidity. The waters have been bottled and sold for the past twenty-five years. It is sold in Atlanta as a table water, and as such enjoys an enviable reputation.

## Catoosa Springs.

(*Catoosa County.*)

*Postoffice*, Ringold. *Location*, in the corner of northwestern Georgia; northwest of Atlanta, the capital city, 100 miles; north of Cedartown, 50 miles; southeast of Chattanooga, Tenn., 25 miles. *Situation*, in a

cradle-like depression, covering about 2 acres, nestling among the mountains of northwest Georgia, at an elevation of 945 feet above sea level. Sandstone Mountain, 1 mile distant, lifts its peak 1800 feet above sea level; from its summit can be viewed the historic Mission Ridge and Lookout Mountain. *Access*, via Ringold Station, on the Atlanta Chattanooga & Western Railway, thence by motor over splendid mountain highways, through a beautifully picturesque, wooded region, 4 miles to the springs. *Hotel*, originally there was a very large commodious resort hostelry here, accommodating from 600 to 700 guests, which was destroyed by fire a few years ago, and at present only a small hotel and a few cottages offer accommodations for guests. There are 12 springs in the area, which boil up through the hard slate on the mountain side; their flow is not affected by local rains nor long draughts. The following analyses show the mineralization:

CATOOSA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Potassium chloride (KCl) | 9.33 | 11.75 | 10.14 | 5.78 |
| Sodium chloride (NaCl) | 3.52 | ... | ... | 4.32 |
| Potassium sulphate ($K_2SO_4$) | ... | 7.14 | 2.00 | |
| Sodium sulphate ($Na_2SO_4$) | 4.30 | 36.41 | 42.07 | 13.08 |
| Magnesium sulphate ($MgSO_4$) | 189.90 | 240.84 | 281.04 | 180.00 |
| Calcium sulphate ($CaSO_4$) | 847.89 | 711.11 | 923.54 | 970.70 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 3.79 | 3.35 | 3.35 | 1.98 |
| Sodium phosphate ($Na_2HPO_4$) | trace | trace | trace | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 181.86 | 345.02 | 295.42 | 24.74 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 6.83 | 7.04 | 10.47 | 1.85 |
| Silica ($SiO_2$) | 18.15 | 31.00 | 70.00 | 16.75 |
| Total solids | 1265.57 | 1393.66 | 1638.03 | 1239.20 |

No. 1, Epsom Spring, medicinal classification, weak calcic sulphated 3 or (−CaS3). This is a moderately mineralized, calcic, magnesic, sulphated saline (aluminic, ferruginous) water, carbon-dioxated.

No. 2, Coffee Spring, medicinal classification, weak calcic sulphated 3 or (−CaS3). This is a moderately mineralized, calcic, magnesic sulphated saline water, carbon-dioxated.

No. 3, Buffalo Lithia Spring, medicinal classification, weak calcic sulphated 3 or (−CaS3). This is a moderately highly mineralized, calcic, magnesic sulphated saline water, carbon-dioxated.

No. 4, Cosmic Spring, medicinal classification, weak calcic sulphated 3 or (−CaS3). This is a moderately mineralized, calcic and magnesic, sulphated saline water, carbon-dioxated.

All of these waters are similar in the percentage of their predominat-

ing chemical constituents, and their medicinal properties are likewise similar. They possess diuretic, tonic and alterative properties, and should be useful in catarrhal disorders of the alimentary tract and in hepatic congestion, etc. The sulphate radicles are sufficiently predominating to excite hepatic function and stimulate slight bowel action, and should cause pleasing evacuations. The iron content makes them of value where an assimilable iron tonic is indicated, such as anemia and chlorosis of young girls just budding into womanhood. The waters are bottled and shipped commercially throughout this and adjoining states.

### Chalybeate Springs.

*(Meriwether County.)*

*Postoffice*, Chalybeate Springs. *Location*, in midwestern Georgia; west of Macon, 74 miles; south of Atlanta, the capital city, 124 miles; south of Greenville, the county seat, 8 miles. *Situation*, on the edge of a beautiful meadow, surrounded by a grove of magnificent oaks, on the southern slope of the outlying spurs of Pine Mountains, at an elevation of about 1000 feet above sea level, surrounded by a picturesque mountainous region. *Access*, only a few hundred yards from Chalybeate Springs Station, on the Atlanta, Birmingham & Atlantic Railway. *Hotel*, accommodation primitive, though good hotels are nearby and private homes which accept guests. The springs some two decades ago were very popular as a resort, and patronized by the citizens from Columbus, Macon and other nearby cities. At present, though their popularity has waned, they still are much visited and the waters shipped extensively. There are a number of springs in this area, but the analyses of only 3 are given herewith:

CHALYBEATE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). Magnesia Spring. | Sulphur Spring. | Chalybeate Spring. |
|---|---|---|---|
| Potassium chloride (KCl) | 2.40 | 4.20 | 3.80 |
| Sodium chloride (NaCl) | 5.10 | 4.90 | 1.90 |
| Sodium sulphate ($Na_2SO_4$) | 13.10 | 13.20 | 7.30 |
| Aluminum sulphate ($Al_2SO_4$) | ... | ... | 2.70 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | 6.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 34.02 | 46.00 | 29.48 |
| Sodium bicarbonate ($Na[HCO_3]_2$) | 11.10 | 12.96 | |
| Calcium bicarbonate ($Ca[CHO_3]_2$) | 62.69 | 83.27 | 49.90 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 9.40 | 14.90 | 11.18 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | ... | ... | 1.29 |
| Aluminum oxide ($Al_2O_3$) | 1.70 | 0.90 | |
| Silica ($SiO_2$) | 41.70 | 37.60 | 21.00 |
| Total solids | 181.21 | 218.13 | 134.55 |
| Gases: | | | |
| Carbon dioxide (free) | 72.00 | 51.00 | 40.40 |

No. 1, Magnesia Spring, is a slightly mineralized, calcic, magnesic, bicarbonated alkaline (ferruginous) water, carbon-dioxated, possessing diuretic antacid and slight tonic properties.

No. 2, Sulphur Spring, is a slightly mineralized, calcic, magnesic bicarbonated alkaline (ferruginous) water, sulphuretted, with slight trace of hydrogen sulphide, possessing diuretic, antacid, tonic and alterative properties.

No. 3, Chalybeate Spring, is a slightly mineralized, calcic, magnesic ferruginous bicarbonated alkaline water, possessing diuretic, antacid, tonic and alterative properties.

## Daniel Mineral Springs.

(*Greene County.*)

*Postoffice,* Union Point. *Location,* northeast of central Georgia; northeast of Macon, 60 miles; east of Atlanta, the capital city, 75 miles; west of Augusta, 60 miles. *Situation,* in a rolling hilly region, at an elevation of about 500 feet above sea level. *Access,* Central Railway of Georgia to Union Point Station, thence by motor 7 miles over splendid macadam highways to the springs. *Hotel,* the accommodations, are two cottages for guests. The springs are beautifully situated on the bank of a small stream amid a beautiful grove of grand old trees. The analysis shows the following:

DANIEL MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). |
|---|---|
| Lithium chloride ($LiCl$) | trace |
| Potassium chloride ($KCl$) | 7.92 |
| Sodium chloride ($NaCl$) | 6.14 |
| Sodium sulphate ($Na_2SO_4$) | 94.25 |
| Magnesium sulphate ($MgSO_4$) | 168.60 |
| Calcium sulphate ($CaSO_4$) | 1305.10 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 2.18 |
| Sodium phosphate ($Na_2HPO_4$) | 0.40 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 287.87 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.78 |
| Silica ($SiO_2$) | 43.20 |
| Total solids | 1920.44 |
| Gases: | |
| Carbon dioxide (free) | 26.00 |

Medicinal classification, weak calcic sulphate 4 or (−CaS4). This is a moderately highly mineralized, calcic, sodic, magnesic, sulphated, saline water, possessing diuretic and tonic properties. The sulphate radicles are in solution in sufficient concentration to cause slight stimulation of the bowels and to awaken hepatic function. The waters should be of value in the treatment of intestinal stasis, constipation, etc. The waters are bottled and shipped extensively.

## Eureka Springs.

(*Dodge County.*)

*Postoffice,* Eureka Springs. *Location,* south of the central portion of the state; southeast of Macon, 50 miles; east of Columbus, 100 miles; west of Savannah, 135 miles. *Situation,* on the side of a swamp lying in a beautiful valley, at an elevation of about 450 feet above sea level. *Access,* via the Central of Georgia Railway, thence a distance of 3 miles to the springs. *Hotel,* on an elevated hill near the springs is a small hotel offering accommodations. There is a small bath-house near the springs, with some conveniences. This spring was formerly known as Jay Bird Spring, and was a natural spring, but a 2-inch pipe has been driven to a depth of 15 feet, and now the waters flow out through this pipe. The analysis below shows the mineralization:

EUREKA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). |
|---|---|
| Potassium chloride (KCl) | 1.90 |
| Sodium chloride (NaCl) | 6.80 |
| Sodium sulphate ($Na_2SO_4$) | 5.00 |
| Sodium bicarbonate ($NaHCO_3$) | 1.49 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 37.42 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 161.61 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.59 |
| Aluminum oxide ($Al_2O_3$) | 0.80 |
| Silica ($SiO_2$) | 18.60 |
| Total solids | 236.12 |

The analysis shows this to be a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water, possessing diuretic, antacid and tonic properties, useful in acid gastric disturbances and in irritable conditions of the genito-urinary tract. The water has the endorsement of local physicians. The waters have been sold extensively.

## Indian Springs.

(*Butts County.*)

*Postoffice,* Indian Springs. *Location,* northwest of central Georgia; southeast of Atlanta, the capital city, 45 miles; northeast of Macon, 40 miles; east of Griffin, 20 miles; west of Flovilla, 3 miles. *Situation,* at the base of a low elevation among the hills of Butts County, at an elevation of about 500 feet above sea level. *Access,* via the Southern Railway to Flovilla Station, thence by motor, a distance of 3 miles to the springs. *Hotel,* there is a commodious resort hostelry, with modern accommodations. There is a bathing establishment, modern in construction and equipment, where the sulphur baths are given as well

as the practice of the whole field of hydrotherapy. The Indian Springs is one of the oldest and most favorably known resorts in the state. The spring issues from the side of a hill, flowing from a fissure in gneissoid rock, with a distinct odor of sulphuretted hydrogen, and in the bottom of a shallow basin into which it flows forms a precipitate of a grayish or whitish color. The analysis below shows the mineralization of this celebrated sulphur water.

INDIAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). |
|---|---|
| Lithium chloride (LiCl) | 0.13 |
| Potassium chloride (KCl) | 4.25 |
| Sodium chloride (NaCl) | 20.71 |
| Sodium sulphate ($Na_2SO_4$) | 37.56 |
| Sodium phosphate ($Na_2HPO_4$) | 0.92 |
| Sodium bicarbonate ($NaHCO_3$) | 36.85 |
| Magnesium biarbonate ($Mg[HCO_3]_2$) | 9.42 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 49.52 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.00 |
| Silica ($SiO_2$) | 23.50 |
| Total solids | 183.86 |

The analysis shows this to be a lightly mineralized, sodic, sulphated and bicarbonated alkaline-saline (phosphatic) water, sulphuretted, possessing diuretic, antacid, tonic and alterative properties. Its administration exerts a pleasing action on disorders of the genito-urinary tract; in large amounts it produces pleasing laxative action. The waters are highly endorsed by Georgia physicians in anasarca when not due to depleted heart action, in rheumatism, rheumatoid arthritis and tertiary syphilis. The sulphur baths are efficacious in the treatment of the severer forms of chronic skin diseases.

## Lifsey Spring.

### (*Pike County.*)

*Postoffice*, Zebulon. *Location*, in western Georgia; south of Atlanta, the capital city, 60 miles; northwest of Macon, 45 miles. *Situation*, at the foot of Pine Mountain at an elevation of about 1000 feet above sea level. *Access*, via the Macon & Birmingham Railway to Zebulon, thence a distance of 7 miles to the springs. *Hotel*, there is a modern resort hostelry and several cottages. There are two large concrete swimming pools. The water "boils" up in numerous pepper-pot-like craters through white sand carrying a large quantity of air, which is free carbon dioxide gas. The analysis shows the mineralization:

LIFSEY SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). |
|---|---|
| Potassium chloride (KCl) | 5.10 |
| Sodium chloride (NaCl) | 3.30 |
| Sodium sulphate ($Na_2SO_4$) | 6.80 |
| Sodium bicarbonate ($NaHCO_3$) | 17.45 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 95.74 |
| Magnesium bicarbonate ($Mg[CHO_3]_2$) | 59.61 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.13 |
| Aluminum oxide ($Al_2O_3$) | 0.70 |
| Silica ($SiO_2$) | 15.50 |
| Total solids | 204.70 |
| Gases: | |
| Carbon dioxide (free), parts per 1,000,000 | 60 |
| Temperature, °C. | 25.8 |
| Flow in gallons per day | 168,000 |

The analysis shows this to be a very lightly mineralized, thermic, calcic, magnesic, sodic, bicarbonated alkaline water, possessing diuretic and antacid properties, useful in the treatment of gastric disturbances due to acidity, and of value in irritable conditions of the bladder and kidneys. Bathing in these thermic waters is said to be a curative in some of the milder chronic skin affections.

## Meriwether White Sulphur Springs.

(*Meriwether County.*)

*Postoffice*, White Sulphur Springs. *Location*, in midwestern Georgia; west of Macon, 78 miles; south of Atlanta, the capital city, 76 miles; west of the celebrated Warm Springs, 10 miles. *Situation*, at the foot of Pine Mountain, at an elevation of 1200 feet above sea level. *Access*, via Meriwether Spring Station, on the Central of Georgia Railway, thence a short distance to the springs, or via Durand Station, on the Atlantic, Birmingham & Atlantic Railway, thence by motor to the springs. *Hotel*, with moderate conveniences, besides a large number of private cottages. The hotel is surrounded by a beautiful landscaped park, shaded with grand old oak trees of virgin growth. The pavilion-like spring house is an attraction to the grounds. There is a group of fine springs in this area, but the analyses of only 3 are given herewith:

No. 1, White Sulphur Spring, is a lightly mineralized, calcic, sodic, bicarbonated, alkaline (ferruginous) water, sulphuretted.

No. 2, Red Sulphur Spring, is a lightly mineralized, calcic, sodic, bicarbonated, alkaline water, sulphuretted.

No. 3, Iron Spring, is a lightly mineralized, sodic, calcic, magnesic, bicarbonated, alkaline water, sulphuretted.

MERIWETHER WHITE SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). Spring No. 1. | Spring No. 2. | Spring No. 3. |
|---|---|---|---|
| Potassium chloride (KCl) | 5.40 | 3.00 | 5.40 |
| Sodium chloride (NaCl) | 7.30 | 3.40 | 1.30 |
| Sodium sulphate ($Na_2SO_4$) | 10.00 | 9.20 | 18.60 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 1.40 | | |
| Sodium phosphate ($Na_2HPO_4$) | trace | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | 26.89 | 35.64 | 16.52 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 20.41 | 15.55 | 15.24 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 80.79 | 86.91 | 85.37 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace | trace | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 8.42 | 2.59 | 7.35 |
| Silica ($SiO_2$) | 47.10 | 32.80 | 42.00 |
| Total solids | 207.81 | 189.09 | 191.78 |

These waters, Spring 1 and 2, are highly endorsed in the treatment of digestive disturbances, bladder and kidney affections and in some of the milder types of chronic skin disorders, rheumatism and gout. Spring No. 3 is a ferruginous, bicarbonated, alkaline water, and is a good tonic water, recommended in anemia, chlorosis and general run-down condition. All of the springs contain free carbonic-acid gas, which adds to the therapeutic potency of the waters.

## Mineral Springs Summer Resort.

(*Walker County.*)

*Postoffice*, La Fayette. *Location*, in the northwest corner of Georgia; south of Chattanooga, Tenn., 24 miles; northwest of Atlanta, the capital city, 84 miles. *Situation*, on the western slope of the outlying spurs of the Blue Ridge Mountains, near the northern terminus of Pigeon Mountain in Cutlett Gap, a natural wind gap connecting Chattanooga Valley with the valley west of Chickamauga Creek, at an elevation of about 1000 feet above sea level. *Access*, via Central of Georgia Railway or the Tennessee, Alabama & Georgia Railway to La Fayette, thence by motor over splendid macadam highways, leading through a beautifully picturesque region of wooded hills and fertile dales to the springs; or by motor over the government national highway, thence a short distance of the springs. *Hotel*, there is a modern club house, with a score or two of open-air sleeping rooms, large dining hall, a modern kitchen, bathing department, tennis, bowling alley and a large lake. There are some 25 springs in this area, 4 of which the mineralization is shown in the following analyses: Page 334.

Spring No. 1 is a lightly mineralized, calcic, magnesic, ferruginous, bicarbonated, alkaline water.

Spring No. 2 is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water.

MINERAL SPRINGS SUMMER RESORT.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 10. | Spring No. 21. |
| Potassium chloride (KCl) | 3.60 | 2.90 | 1.10 | 1.50 |
| Sodium chloride (NaCl) | 5.10 | 9.20 | 6.10 | 4.60 |
| Sodium sulphate ($Na_2SO_4$) | 13.60 | 24.90 | 3.10 | 0.60 |
| Magnesium sulphate ($MgSO_4$) | 6.10 | ... | ... | 11.00 |
| Calcium sulphate ($CaSO_4$) | ... | ... | ... | 10.20 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | ... | 0.60 |
| Ferrous sulphate ($FeSO_4$) | ... | ... | ... | 9.20 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 40.82 | 45.36 | 41.14 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 136.08 | 147.42 | 140.94 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 18.79 | 10.69 | 4.05 | 8.91 |
| Aluminum oxide ($Al_2O_3$) | 1.40 | 0.80 | 0.80 | |
| Silica ($SiO_2$) | 23.00 | 19.00 | 12.00 | 18.00 |
| Total solids | 268.49 | 260.27 | 210.23 | 64.61 |

Spring No. 10 is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water.

Spring No. 21 is a slightly mineralized, calcic and magnesic sulphated saline water.

Springs No. 1, 2 and 10 show quite similar percentages in the predominating chemical constituents; they possess practically the same therapeutic properties, diuretic, antacid and slight tonic action. These waters ought to be of use in the treatment of gastric disorders due to acidity and of value in irritable conditions of the bladder and kidneys, etc.

Spring No. 21 possesses slight diuretic and tonic properties, and should be of use in the treatment of bladder and kidney irritation in doses of 3 or more liters daily.

## Miona Mineral Springs.

(*Macon County.*)

*Postoffice,* Oglethorpe, R. F. D. No. 3. *Location,* to the southwest of the center of the state; southwest of Macon, 50 miles; east of Columbus, 60 miles; west of Dublin, 50 miles. *Situation,* on the right bank of the Flint River, which drains a beautiful valley of the same name as the river. Near the margin of a river swamp, all within the space of a few acres, arise this group of 8 springs. *Access,* via Oglethorpe Station, on the Central of Georgia Railway, thence by motor 8 miles to the springs. *Hotel,* the hotel is a wooden structure without modern conveniences. There is a large swimming pool for bathing purposes.

A 600-acre farm well cultivated insures an abundance of fruit and vegetables, as well as from the dairy, milk butter and cream, for the dining room. The water, on analysis, from the various springs shows the following mineralization:

MIONA MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | |
|---|---|---|---|---|---|
| | Analyst, R. M. Hicks. | Analyst, Dr. E. Everhardt. | Analyst, R. M. Hicks. | | Analyst, Dr. E. Everhardt. |
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 7. |
| Potassium chloride (KCl) | 0.472 | 1.000 | 0.214 | 2.587 | 12.800 |
| Sodium chloride (NaCl) | 3.823 | 5.800 | 2.674 | 3.855 | 15.600 |
| Potassium iodide (KI) | ... | ... | .... | 0.005 | |
| Sodium sulphate ($Na_2SO_4$) | 12.280 | ... | 3.232 | 5.628 | 2.100 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 0.610 | 0.900 | 0.001 | 0.050 | |
| Magnesium sulphate ($MgSO_4$) | ... | ... | ... | ... | 4.200 |
| Calcium sulphate ($CaSO_4$) | ... | 4.100 | | | |
| Lithium bicarbonate ($Li[HCO_3]_2$) | ... | ... | ... | 0.011 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 3.748 | 3.888 | 5.423 | 6.624 | 6.804 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 18.248 | ... | 19.231 | 7.418 | 8.000 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.880 | 3.726 | 0.012 | 0.148 | 15.228 |
| Aluminum oxide ($Al_2O_3$) | ... | 0.100 | | | |
| Silica ($SiO_2$) | 6.440 | 8.800 | 6.280 | 7.870 | 10.500 |
| Total solids | 48.501 | 28.414 | 37.067 | 34.196 | 75.232 |

Spring No. 1 is a slightly mineralized, calcic, bicarbonated, sodic sulphated alkaline-saline (ferruginous) water, possessing diuretic and antacid properties with tonic action.

Spring No. 2 is a slightly mineralized, calcic, muriated, ferruginous bicarbonated alkaline-saline water, possessing diuretic, antacid and slight tonic properties.

Spring No. 3 is a slightly mineralized, calcic, bicarbonated, alkaline water, possessing slight antacid properties.

Spring No. 4 is a slightly mineralized, calcic, magnesic, bicarbonated, sodic, sulphated, alkaline-saline water, possessing diuretic properties.

Spring No. 7 is a lightly mineralized, sodic, potassic, muriated and ferruginous bicarbonated, alkaline-saline water, possessing diuretic and tonic properties.

There are quite a variety of waters in this spring area; besides the above, there are 4 other springs, all coming from the earth sparkling like champange. The natural carbonic-acid gas with which the waters are charged adds to its palatability and therapeutic usefulness.

## Rowland Springs.

(*Bartow County.*)

*Postoffice*, Cartersville. *Location*, in northwestern Georgia; southeast of Rome, 25 miles; northwest of Atlanta, the capital city, 35 miles. *Situation*, in a broken hilly country, at an elevation of about 1500 feet above sea level. *Access*, via the Atlantic Coast Line Railway to Cartersville, thence by motor 6 miles, northeast of Cartersville, to the springs. *Hotel*, prior to the years 1861–1865 this was one of the most popular resorts in Georgia, with hotel accommodations for 500 guests, but of late years the conveniences did not keep pace with the times and now only limited accommodations are available. There are 4 springs in this area, 2 of which have been analyzed:

ROWLAND SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). Spring No. 1. | Spring No. 2. |
|---|---|---|
| Potassium chloride (KCl) | 5.58 | 5.70 |
| Sodium chloride (NaCl) | 3.46 | 4.60 |
| Sodium sulphate ($Na_2SO_4$) | 9.99 | 13.70 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 1.67 | |
| Sodium phosphate ($Na_2HPO_4$) | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | 26.89 | 22.19 |
| Magnesium bicarbonate ($MgHCO_3]_2$) | 20.10 | 14.90 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 75.81 | 66.58 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 0.52 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 12.68 | 5.18 |
| Aluminum oxide ($Al_2O_3$) | ... | 0.70 |
| Silica ($SiO_2$) | 41.50 | 36.20 |
| Total solids | 198.20 | 169.75 |
| Gases: | | |
| Carbon dioxide (free), parts per 1,000,000 | 101.52 | 75.3 |

Spring No. 1 is a lightly mineralized, sodic, magnesic, ferruginous, bicarbonated alkaline water.

Spring No. 2 is a lightly mineralized, calcic, sodic, magnesic, bicarbonated alkaline water.

The percentage of the predominating chemical constituent of the two springs are very similar and possess diuretic, antacid, tonic and alterative properties. The waters are said to be efficacious in the treatment of diseases of the stomach and kidneys.

## Thunder Springs.

(*Upson County.*)

*Postoffice*, Thunder. *Location*, in midwestern Georgia; west of Macon, 50 miles; south of Atlanta, the capital city, 55 miles. *Situation*,

near the base of Pine Mountain, at an elevation of 1000 feet above tide water. Not far from the spring is Dropping Rock, a wild gorge in Pine Mountain, through which passes the Flint River. The spring takes its name from the rumbling noise produced by the escape of gas from the spring, which resembles the rumblings of distant thunder; these reverberations were very loud at one time, but this noise has apparently ceased in latter years, but nevertheless there is a large amount of gas still escaping. *Access*, via the Macon & Birmingham Railway to Thunder Station, only a few hundred yards from the the springs. *Hotel*, there have been built two hotels at the springs, but both have been destroyed by fire; the accommodations at present are very primitive. The sand in this spring is somewhat different from other sand, in that when it is crushed in the hand it crackles—not unlike that of freshly fallen snow. The analysis below shows the mineralization:

THUNDER SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). |
|---|---|
| Potassium chloride (KCl) | 2.9 |
| Sodium chloride (NaCl) | 6.9 |
| Sodium sulphate ($Na_2SO_4$) | 0.9 |
| Sodium bicarbonate ($NaHCO_3$) | 0.9 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 18.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 81.9 |
| Aluminum oxide ($Al_2O_3$) | 0.6 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.3 |
| Silica ($SiO_2$) | 8.5 |
| Total solids | 122.2 |
| Temperature, °C. | 24.4 |

The analysis shows this to be a lightly mineralized, thermic, calcic and magnesic bicarbonated alkaline water, possessing diuretic, antacid and tonic properties. The water has some local reputation in the relief of gastric disturbances and kidney and bladder disorders.

## Waco Mineral Springs.

### (*Haralson County.*)

*Postoffice*, Waco. *Location*, in western Georgia; west of Atlanta, the capital city, 50 miles; north of Columbus, 100 miles; south of Rome, 40 miles; northwest of Macon, 105 miles. *Situation*, in a small depression, at the base of a crescent-shaped bluff, at an elevation of about 1000 feet above sea level. *Access*, via the Southern Railway to Waco, thence by motor $\frac{3}{4}$ mile to the springs. *Hotel*, there are only primitive accommodations at the springs, but good hotel with modern conveniences at Waco. The springs have been used medicinally since 1886. There are about 40 springs in this area, comprising less than 1 square acre, but only 2 have been analyzed: No. 1, Iron

Spring, and No. 2, Eye Spring, the latter being so named on account of the supposed healing properties of its water when applied to inflammation of the eyes.

WACO MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). Spring No. 1. | Spring No. 2. |
|---|---|---|
| Potassium chloride (KCl) | 1.00 | 1.00 |
| Sodium chloride (NaCl) | 4.20 | 4.20 |
| Sodium sulphate ($Na_2SO_4$) | 9.50 | 5.50 |
| Calcium sulphate ($CaSO_4$) | 3.10 | 3.30 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 5.67 | 5.67 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 2.43 | 16.20 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 20.08 | 1.78 |
| Silica ($SiO_2$) | 11.00 | 9.00 |
| Total solids | 56.98 | 46.65 |
| Gases: | | |
| Carbon dioxide (free), parts per 1,000,000 | 6.0 | 13.1 |

No. 1, Iron Spring, is a slightly mineralized, ferrous, bicarbonated and sodic sulphated, alkaline-saline water, possessing diuretic, tonic and alterative properties. This water is useful in the treatment of anemia, chlorosis and general run-down conditions where there is need for an iron tonic. Its use ought to be advantageous in all depraved conditions of the blood and blood-making organs.

No. 2, Eye Spring, is a slightly mineralized, calcic and magnesic, bicarbonated alkaline water, possessing similar therapeutic properties to Spring No. 1; both contain free carbonic-acid gas.

## Warm Springs.

(*Merriwether County.*)

*Postoffice*, Warm Springs. *Location*, in midwestern Georgia; west of Macon, 70 miles; south of Atlanta, the capital city, 75 miles. *Situation*, at the base of one of the foothills of Pine Mountains, at an elevation of 1200 feet above sea level. *Access*, via the Southern Railway, thence by motor 1 mile to the Springs. *Hotel*, there is a well-kept modern hotel, with modern conveniences. There is a splendid system of baths, two magnificent swimming pools for swimming devotees. The prominent feature of the resort is the warm springs gushing from the base of Pine Mountain, at the rate of 2,000,000 gallons daily, without variation from flood or drought. The water has a temperature of 32.2° C. (90° F.) and is one of the few warm springs in the country. The spring flows from a quartzite ledge at the margin of a small meadow. The analysis on page 339 shows the mineralization.

This is a lightly mineralized, thermic, calcic, magnesic bicarbonated alkaline water, possessing antacid, diuretic and slight tonic properties.

WARM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). |
|---|---|
| Potassium chloride (KCl) | 0.55 |
| Sodium chloride (NaCl) | 4.84 |
| Sodium sulphate ($Na_2SO_4$) | 3.30 |
| Magnesium sulphate ($MgSO_4$) | 1.26 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 2.70 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 59.77 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 86.00 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.91 |
| Silica ($SiO_2$) | 22.75 |
| Total solids | 184.08 |
| Gases: | |
| Carbon dioxide (free), parts per 1,000,000 | 41.27 |
| Temperature, °C. | 32.2 |
| Flow in gallons per day | 2,721,600 |

These waters are highly endorsed in the treatment of gastric affections, rheumatism and the uric-acid diathesis, and in hepatic and renal disorders in skin affections. In cases of general debility and run-down conditions generally the use of the waters as "drinking cures," aided by the bracing mountainous atmosphere, induces rapid establishment of health and renewed vitality.

## White Oak Mineral Wells.

(*Bibb County.*)

*Postoffice*, Macon. *Location*, near the geographical center of the state; southwest of Augusta, 100 miles; southeast of Atlanta, 120 miles; northeast of Columbus, 130 miles; 4 miles west of Macon. *Situation*, in a rolling, undulating section of country, well drained and salubrious. Two of the wells, those from which the water is now being put on the market, are within a few feet of each other, while the other 2 are several hundred yards distant, one being on an adjacent hill and the other in an intervening valley. *Access*, via Macon, on the Central of Georgia Railway, thence 4 miles to the wells. *Hotel*, no accommodation for guests. The following analysis of Well No. 1 shows the mineralization:

WHITE OAK MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). |
|---|---|
| Sodium chloride (NaCl) | 84.00 |
| Potassium chloride (KCl) | 3.80 |
| Sodium sulphate ($Na_2SO_4$) | 143.20 |
| Magnesium sulphate ($MgSO_4$) | 480.00 |
| Calcium sulphate ($CaSO_4$) | 551.50 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 48.75 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 11.66 |
| Aluminum oxide ($Al_2O_3$) | 2.60 |
| Silica ($SIO_2$) | 73.00 |
| Total solids | 1498.51 |
| Gases at 0° C. and 760 mm. pressure, cc. per liter: | |
| Carbon dioxide (free) | 28 |

Medicinal classification, weak sulphated 3 or (−S3). The analysis of this well shows a moderately highly mineralized, calcic, sodic magnesic, sulphated, saline water, possessing diuretic and antacid properties. This water is of use in catarrhal conditions of the mucous surfaces of the intestinal tract, and enjoys a large sale in Macon and adjoining towns.

## White Path Mineral Springs.

*(Gilmer County.)*

*Postoffice*, White Path. *Location*, in northern Georgia; north of Atlanta, the capital city, 70 miles; east of Dalton, 30 miles; west of Talula Falls, 60 miles. *Situation*, at the base of one of the spurs of Turniptown Mountain, whose highest peak reaches an altitude of nearly 4000 feet above sea level. *Access*, White Path Station, on the Atlanta & Knoxville Railway, thence a short distance by motor to the springs. *Hotel*, accommodations primitive. There are a number of springs in this area, of which we present the analyses of the following:

WHITE PATH MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Edgar Everhardt). | | | |
|---|---|---|---|---|
| | Chalybeate Spring. | Magnesia Spring. | House Spring. | Mountain Spring. |
| Potassium chloride ($KCl$) | 0.95 | 0.18 | 1.20 | 1.90 |
| Sodium chloride ($NaCl$) | 7.33 | 5.63 | 2.40 | 7.00 |
| Sodium sulphate ($Na_2SO_4$) | 17.68 | 0.46 | 3.00 | 1.40 |
| Magnesium sulphate ($MgSO_4$) | 2.91 | 1.19 | 3.20 | |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 1.35 | 0.30 | | |
| Sodium phosphate ($Na_2HPO_4$) | 1.40 | | | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | .... | 2.75 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 9.62 | 6.93 | ... | 6.15 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 43.42 | 9.25 | 3.40 | 10.04 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 9.07 | 6.00 | 0.97 | 0.48 |
| Aluminum oxide ($Al_2O_3$) | ... | ... | 0.10 | 0.10 |
| Silica ($SiO_2$) | 32.60 | 10.82 | 9.10 | 17.40 |
| Total solids | 126.33 | 40.76 | 23.37 | 46.20 |
| Gases: | | | | |
| Carbon dioxide, parts per 1,000,000 | 29.5 | 19.6 | 5.0 | 4.0 |

The Chalybeate Spring is a lightly mineralized, calcic, bicarbonated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid and slight tonic properties.

The Magnesia Spring is a slightly mineralized, calcic and magnesic bicarbonated and muriated alkaline-saline water.

The House Spring is a slightly mineralized magnesic and sodic and muriated saline water.

The Mountain Side Spring is a slightly mineralized, calcic, bicarbonated and sodic muriated alkaline-saline water.

The waters from Chalybeate, Magnesia and Mountain Springs possess diuretic, antacid and slight tonic properties. The House Spring is a good potable table water and very pure and wholesome.

### White Sulphur Springs.

(*Hall County.*)

*Postoffice*, R-5, Gainsville. *Location*, in the northern portion of the state; northwest of Atlanta, the capital city, 60 miles; east of Rome, 75 miles. *Situation*, in the foothills of the Blue Ridge Mountains in northern Georgia, 1500 feet above sea level. *Access*, via Gainesville Station, 6 miles from the springs, on the Southern Railway, thence by motor to the springs. *Hotel*, the hotel is a modern resort hostelry, with numerous cottages, offers accommodations for 200 or more guests. The analysis of the water from the White Sulphur Springs shows the following mineralization:

WHITE SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Georgia Geological Survey). |
|---|---|
| Lithium chloride ($LiCl$) | trace |
| Potassium chloride ($KCl$) | 8.78 |
| Sodium chloride ($NaCl$) | 1.76 |
| Sodium sulphate ($Na_2SO_4$) | 4.79 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 1.34 |
| Sodium phosphate ($Na_2HPO_4$) | trace |
| Sodium arsenate ($Na_2HAsO_4$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 95.32 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 20.40 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 64.80 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.56 |
| Silica ($SiO_2$) | 22.00 |
| Total solids | 222.75 |

Medicinal classification, sulphuretted. The spring flows slightly less than 2 gallons per minute, and has a marked odor of sulphuretted hydrogen. A careful study of the analysis shows a lightly mineralized, sodic, calcic, bicarbonated, alkaline water, sulphuretted, possessing antacid, diuretic and tonic properties; it has long been used by and highly endorsed by the profession in the treatment of kidney and bladder affections, gastric and intestinal disorders, hepatic diseases and catarrh of the gall ducts, rheumatism and skin disorders.

The following springs have been used as resorts:

*Dixon Springs, P. O.*, Toomsboro, Wilkinson County. Once known as Cannon's Springs, and previously as Myrtle Springs. No definite information nor satisfactory analysis available. For want of improvements, it has passed into comparative obscurity.

*Claremonde Chalybeate Springs, P. O.*, Worthen, Washington County. No definite information nor satisfactory analysis available; correspondence unanswered.

*Franklin Springs, P. O.*, Royston, Franklin County. This place once had a considerable reputation as a resort, but no definite information nor satisfactory analysis available. For want of enterprise, it has been allowed to pass into comparative obscurity.

*Hughes' Mineral Springs, P. O.*, Rome, Floyd County. This is a magnesic, calcic, saline water of considerable value, and had the endorsement of the local profession, but could not secure definite information nor satisfactory analysis.

*Magnolia Springs, P. O.*, Plains of Dara, Sumpter County. Once a popular local resort. No definite information nor satisfactory analysis available; correspondence not answered.

*Ponce de Leon Spring, P. O.*, via R.F.D., Atlanta, Fulton County. This spring is said to have been discovered in 1871 and used locally. No definite information nor satisfactory analysis obtainable.

*Porter Springs, P. O.*, Porter Springs, Lumpkin County. Hotel and cottages. Elevation, 3000 feet above sea level. No definite information nor satisfactory analysis available.

*Powder Springs P. O.*, Powder Springs, Cobb County. These springs were discovered about seventy-five years ago, but for want of development and the necessary improvement, the reputation is entirely local. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Watson Springs P. O.*, Maxeys, Green County. Once a resort with local reputation. No definite information nor satisfactory analysis available.

The following springs reported the commercial sale of water in 1924:

*Abbeville Spring, P. O.*, Abbeville, Wilcox County.
*Cliff Rock Spring, P. O.*, Atlanta, Fulton County.
*Cohutta Spring, P. O.*, Crandall, Murray County.
*Cox Mineral Spring, P. O.*, Waynesboro, Burke County.
*Duke Mineral Spring, P. O.*, Cedartown, Polk County.
*Electric Lithia Spring, P. O.*, Hillman, Taliaferro County.
*Caskin Spring, P. O.*, Douglas, Coffee County.
*High Rock Magnesia Spring, P. O.*, Atlanta, Fulton County.
*Menlo Spring, P. O.*, Rome, Chattanooga County.
*Miller's Mineral Spring, P. O.*, Milledgeville, Baldwin County.
*Murrow Spring, P. O.*, Tifton, Tifton County.
*Pine Mountain Spring, P. O.*, West Point, Troup County.
*Post Mineral Spring, P. O.*, Holly Springs, Cherokee County.
*Swift Lithia Springs, P. O.*, Elberton, Elbert County.
*Utoy Rock Spring, P. O.*, Atlanta, Fulton County.
*White Elk Spring, P. O.*, Macon, Box 546, Bibb County.
*Wild Rose Spring, P. O.*, Eastman, Dodge County.
*Windsor Spring, P. O.*, Augusta, Richmond County.

## IDAHO.

Idaho extends from 42° to 49° north latitude and from 111° to 117° west longitude, and comprises an area of 82,294 square miles, including 510 square miles, covered by lakes. The surface of Idaho is elevated and mostly mountainous. The Bitter Root Mountains, a chain of the Rockies, form the northeastern boundary and cover a considerable portion of the state. Some of the mountain ranges rise to the snow line, more than 5000 feet above sea level. The climate is cool and healthful, the mean annual temperature being 12.7° C. (52.46° F.). The climate in the elevated sections of the state is very severe, with heavy snowfall lasting all winter; the plains and valleys have a milder climate, free from the extremes, as the summers are moderated by mountain breezes.

Idaho has 32 spring localities, with 114 individual springs, only a few of which have been analyzed. The chemical composition of the mineral springs in Idaho is so little known that they cannot be definitely classified beyond stating that the thermic springs predominate. Geologically the state has underlying a strate of paleozoic, mesozoic and later ages alternate with eruptive and metaphoric rocks. Along the Snake River is a vast bed of lava forming a desert nearly 400 miles long by 40 to 60 miles in width, the eastern end of a volcanic belt that extends to the Pacific. The fissures from which the molten rock poured out during the tertiary period are more or less concealed, although their position may be readily indicated by lines of flow. Granite and volcanic rocks prevail and, in connection with the mountain corrugation, present most favorable conditions for the development of hot springs. Hot and warm springs are freely distributed throughout the granite area, and in many instances issue forth directly through the granite, although usually a mile or so distant from known volcanic rocks. The list here presented has been collected from correspondence mainly and from a short visit to Warm Springs, Boise City, in person, from Peale's list and from Crook's work. Although very few of the springs have been improved, yet a number are used for bathing. The most widely known resort is the Soda Springs, near the bend of the Bear River.

### IDAN-HA SPRINGS.

(*Bannock County.*)

*Postoffice,* Soda Springs. *Location,* in southeastern Idaho; east of Boise City, the capital, 250 miles; southwest of the Yellowstone National Park, 127 miles. *Situation,* in a mountainous region of precipitous peaks, gaping chasms, eroded hills and mighty boulders—mute evidence of great volcanic upheavals of the long ago. The elevation is about 6000 feet above tide water. *Access,* via the South-

ern Pacific Railway System and connections, thence by motor 2 miles to the springs. *Hotel*, there are several hostelries, with modern conveniences. There are a number of springs in this area, Harshoe, Octagon, Williams, Mount Blanche, and in the near vicinity Mammouth, Steamboat, Hooper, Jewsharp and Freshwater. The latter furnishes the water supply for the town by pipe line from the springs. The Idan-ha Spring has the following mineralization, as shown by analysis:

IDAN-HA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Charles F. Chandler). |
|---|---|
| Sodium chloride (NaCl) | 225.54 |
| Potassium sulphate ($K_2SO_4$) | 20.81 |
| Sodium sulphate ($Na_2SO_4$) | 35.51 |
| Sodium bromide (NaBr) | trace |
| Sodium phosphate ($Na_2HPO_4$) | 11.62 |
| Sodium biborate ($NaBO_2$) | trace |
| Lithium bicarbonate ($LiHCO_3$) | 36.34 |
| Sodium bicarbonate ($NaHCO_3$) | 213.33 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1729.60 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1577.90 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace |
| Magnanese bicarbonate ($Mn[HCO_3]_2$) | 44.92 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 2.21 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.32 |
| Aluminum oxide ($Al_2O_3$) | 0.85 |
| Silica ($SiO_2$) | 60.87 |
| Total solids | 4160.82 |

Medicinal classification, alkaline b2 or (Ab2). The analysis shows this to be a moderately highly mineralized, magnesic, calcic, sodic, bicarbonated, alkaline (manganic, phosphatic, baric) water, possessing diuretic antacid, mild aperient, tonic and alterative properties.

## Soda Springs.

(*Bannock County.*)

*Postoffice*, Soda Springs. *Location*, in southeastern Idaho; east of Boise City, the capital, 250 miles; southwest of the Yellowstone National Park, 125 miles. *Situation*, in a wide, rugged, mountainous region, with precipitous peaks, gaping chasms, weird canyons—all presenting evidence of former volcanic disturbances, eroded hills, mighty boulders, giving mute evidence of the long ago; elevation about 6000 feet above tide water. *Access*, via the Southern Pacific Railway System and connections. *Hotel*, there are fair hotel accommodations. There are about 40 springs in this area, varying in temperature from 11.1° C. (52° F.) to 26.7° C. (80° F.). The analysis on the following page shows the mineralization:

SODA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 153.21 |
| Magnesium chloride ($MgCl_2$) | 76.60 |
| Calcium sulphate ($CaSO_4$) | 90.97 |
| Magnesium sulphate ($MgSO_4$) | 827.64 |
| Calcium sulphate ($CaSO_4$) | 145.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 365.90 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 428.72 |
| Ferric oxide and alumina ($FeO_3$, $Al_2O_3$) | 31.00 |
| Silica and organic matter ($SiO_2$) | 10.00 |
| Total solids | 2037.18 |

Medicinal classification, weak alkaline b2, weak sulphate 3 or (−Ab2, −S3). The analysis shows this to be a moderately highly mineralized, sodic, muriated, magnesic, calcic, sulphated, bicarbonated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, laxative and tonic properties, and useful in a variety of disorders in which this class of waters are indicated. Sluggish action of the bowels, retarded hepatic function, and gastric disorders due to acidity.

The following places were once used as resorts:

*Warm Spring, P. O.*, Idaho City, Boise County. These springs are located in a mountainous region, 3940 feet above sea level. There are 5 springs in this area, some of which have a very large flow. No definite information nor satisfactory analysis available.

*Bruneau Hot Springs, P. O.*, Bruneau Valley, Owyhee County. These are thermic springs; temperature, 40.8° C. (105° F.); flow, 70,000 gallons per hour. No definite information nor satisfactory analysis available.

*Given's Hot Springs, P. O.*, Snake River, Owyhee County. There are 2 springs in this area, flowing 2000 gallons per hour; temperature, 36.7° C. (98° F.). No definite information nor satisfactory analysis available.

*Warm Sulphur Springs, P. O.*, Lincoln Lake. This is a sulphur water. No definite information nor satisfactory analysis available.

## ILLINOIS.

Illinois extends from 37°3′ to 42°30′ north latitude and from 87°30′ to 91°40′ west longitude, and embraces an area of 55,410 square miles, of which 650 square miles are water. The surface of the state is generally level, gently sloping from north and east toward the Mississippi and Ohio Rivers. It is by no means an unbroken plain, as the many large streams have cut deep beds in the yielding alluvial soil, forming in places deep precipitous slopes and bluffs. In the extreme northwest there are hills rising to the height of 800 feet, but the average elevations range from 600 feet in the north to 300 feet in the

south. Chicago has an elevation of 582 feet above sea level. The climate is generally variable, marked by great extremes, the summers being warm and the winters very cold. The mean annual temperature is above 11.1° C. (52° F.), that of the summer being about 24° C. (75° F.), and the winter 2.3° C. (28° F.). The climate is generally salubrious, except in the low, swampy bottoms, where malarial fevers are frequent.

Illinois has 52 spring localities, with a total of 91 individual springs, of which 14 have been analyzed and 6 used as resorts. The state appears to have a fair proportion of mineral springs, although few are used commercially or as resorts; chalybeate and sulphuretted, saline waters predominate. Brine springs are found in a number of counties. Comparatively few of the Illinois springs have been analyzed, and but few have acquired much prominence as resorts. The lists given herewith were largely secured through the office of the State Geologist and published works, and, while not complete, is fairly representative of the number of active springs in the state today.

### American Carlsbad Springs.

*(Washington County.)*

*Postoffice,* Nashville. *Location,* in southern Illinois; south of Springfield, the capital city, 100 miles; southeast of St. Louis, Mo., 55 miles. *Situation,* in a rolling hilly country, well wooded and drained. The climate is pleasant in summer but cold in midwinter. The springs issue from carboniferous limestone, lying deep below the surface. They issue from a fault and flow freely. The altitude is about 900 feet above sea level. *Access,* via the Louisville & Nashville Railway and the Centralia Railway. *Hotel,* there is a modern hotel, with conveniences. The analysis shows the mineralization:

AMERICAN CARLSBAD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Ludeking). |
|---|---|
| Sodium chloride ($NaCl$) | 171.0 |
| Sodium sulphate ($Na_2SO_4$) | 906.3 |
| Magnesium sulphate ($MgSO_4$) | 1776.2 |
| Calcium sulphate ($CaSO_4$) | 1125.1 |
| Sodium bicarbonate ($NaHCO_3$) | 290.3 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.6 |
| Silica ($SiO_2$) | 0.9 |
| Total solids | 4270.4 |

Gases:
Carbon dioxide present, but not estimated.

Medicinal classification, sulphate 2 or (S2). The analysis shows this to be a moderately highly mineralized, magnesic, sodic, calcic, sulphated, saline water, carbon-dioxated, possessing diuretic and laxa-

tive properties. The waters are not well named, for the similarity to the water at Carlsbad are not sufficiently close to warrant this appellation. They undoubtedly possess potent therapeutic properties and should be useful in the treatment of the various diseases known to be benefited by this type of water: Sluggish action of the bowels and liver, chronic constipation, intestinal stasis, rheumatic disorders, renal and vesical disorders and chronic skin affections.

### Aquæ Vitæ Spring.

*(Knox County.)*

*Postoffice*, Maquan. *Location*, northwest of central Illinois; northwest of Springfield, the capital city, 80 miles; west of Peoria, 35 miles; east of Burlington, Iowa, 30 miles; southeast of Galesburg, 20 miles; northwest of Bloomington, 65 miles. *Situation*, in a rolling prairie region, about 800 feet above sea level, surrounded by a fertile farming region. *Access*, Chicago & Alton Railway. *Hotel*, there are fair accommodations. The spring shows the following analysis:

AQUA VITÆ SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. W. Stark). |
|---|---|
| Potassium chloride (KCl) | 10.1 |
| Sodium chloride (NaCl) | 1.1 |
| Ammonium sulphate ($[NH_4]_2SO_4$) | 4.4 |
| Sodium sulphate ($Na_2SO_4$) | 73.3 |
| Magnesium sulphate ($MgSO_4$) | 1345.8 |
| Calcium sulphate ($CaSO_4$) | 1572.3 |
| Ferrous sulphate ($FeSO_4$) | 949.5 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 421.6 |
| Potassium nitrate ($KNO_3$) | 1.5 |
| Silica ($SiO_2$) | 15.5 |
| Sulphuric acid, free ($H_2SO_4$) | 35.9 |
| Total solids | 4431.0 |

Medicinal classification, sulphate, weak acid aluminic, weak ferruginous 2.5 or (S, −AcAl, −Fe2.5). This is a moderately highly mineralized, calcic, magnesic, ferric, aluminic sulphated, acid water, possessing diuretic, styptic, astringent, laxative, tonic and alterative properties. This is a rather remarkable water, containing free sulphuric acid. This type of water is unknown in Europe. This water is quite similar to the Texas Sour Wells; the Oak Orchard Springs, in New York; the Iowa Acid Spring and the Gaylord and Gulick Springs in Pennsylvania.

### Creal Springs.

*(Williamson County.)*

*Postoffice*, Creal Springs. *Location*, in southern Illinois; north of Paducah, Ky., 53 miles; southwest of St. Louis, Mo., 124 miles; southeast of Evansville, Ind., 85 miles; south of Centralia, 50 miles.

*Situation*, in a beautiful valley, drained by Sugar Creek, at an elevation of 1200 feet above sea level, and lying in the heart of the Ozark Mountains, surrounded by a beautiful panorama of wooded hills and fertile fruit and dairy farms. *Access*, via Creal Springs Station, on the Illinois Central Railway, thence only a short distance to the springs. *Hotel*, there is a commodious brick hostelry, with modern convenience. In addition there is a sanitarium and bathing establishment, both modern in construction and equipment, directed by a competent physician, who advises concerning the "water cure" and the system of baths. The hotel is surrounded by a beautiful landscaped park, in which 11 springs are situated; through this park winds a meandering stream with beautiful waterfalls, which add to the sylvian scenery, beautiful and attractive. The following analyses shows the mineralization of the waters:

CREAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 5. | Spring No. 7. |
| Potassium (KCl) | 46.67 | 59.96 | 41.18 | 149.96 | | |
| Sodium chloride (NaCl) | 326.20 | 1561.28 | 1153.73 | 217.78 | 1.42 | 78.53 |
| Magnesium chloride ($MgCl_2$) | ... | ... | ... | 626.64 | | |
| Calcium chloride ($CaCl_2$) | ... | ... | ... | 117.50 | | |
| Sodium bromide (NaBr) | 36.27 | 2.19 | | | | |
| Potassium sulphate ($K_2SO_4$) | ... | 201.72 | ... | ... | 1.71 | |
| Sodium sulphate ($Na_2SO_4$) | 109.50 | ... | 201.82 | ... | 16.70 | 78.36 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | ... | ... | 434.04 | 104.02 |
| Calcium sulphate ($CaSO_4$) | 37.78 | 176.79 | 244.09 | 2027.20 | 1297.32 | |
| Ferrous sulphate ($FeSO_4$) | ... | ... | 63.45 | | | |
| Sodium nitrate ($NaNO_3$) | ... | ... | 0.40 | ... | ... | 95.14 |
| Sodium phosphate ($Na_3PO_4$) | ... | trace | | | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 273.68 | 110.73 | 107.76 | 54.99 | 172.96 |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | ... | 95.58 | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 146.27 | 17.29 | 53.38 | 331.39 | 104.43 | 334.26 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 36.72 | 5.87 | 43.17 | 14.92 | 53.69 | 0.55 |
| Aluminium oxide ($Al_2O_3$) | 8.02 | ... | ... | 8.73 | 2.32 | 2.05 |
| Silica ($SiO_2$) | 11.00 | 62.93 | 89.77 | 163.84 | 2.25 | 28.39 |
| Total solids | 758.43 | 2365.71 | 2001.72 | 3861.29 | 1968.47 | 894.26 |

Spring No. 1, medicinal classification, weak saline or (−Cl). This is a moderately mineralized, sodic muriated and sulphated saline water, possessing diuretic, tonic and alterative properties.

Spring No. 2, medicinal classification, weak saline 4, weak sulphated or (−Cl 4, −S). This is a moderately highly mineralized, sodic muriated, potassic calcic sulphated saline (bromic) water, possessing diuretic, laxative and tonic properties.

Spring No. 3, medicinal classification, weak saline 3, weak sulphated, very weak ferruginous 0.5 or (−Cl 3, −S, − −Fe 0.5). This is a

moderately highly mineralized, sodic, muriated and sodic and calcic sulphated saline (ferruginous) water, possessing diuretic and tonic properties.

Spring No. 4, medicinal classification, weak alkaline b, weak saline 3, calcic sulphate or (−Ab, −Cl 3, CaS). This is a moderately highly mineralized, calcic sulphated and potassic, sodic, magnesic calcic muriated saline water, possessing diuretic, tonic and alterative properties.

Spring No. 5, medicinal classification, weak calcic sulphated 4, very weak ferruginous 0.5 or (−CaS4, − −Fe0.5). This is a moderately highly mineralized, calcic sulphated, ferrous, bicarbonated-saline water, possessing diuretic and tonic properties.

Spring No. 7, medicinal classification, weak alkaline b or (−Ab.) This is a moderately mineralized calcic, magnesic, bicarbonated alkalinesaline water, possessing diuretic, antacid and slight tonic properties.

The predominating chemical constituents are quite similar in percentage proportions in these waters, and are highly recommended by the profession in a great variety of diseased conditions: Catarrhal disturbances of the gastro-enteric tract, jaundice and other hepatic troubles, rheumatism and chronic joint disturbances, diseases of the kidneys and bladder.

## Dixon Springs.

(*Pope County.*)

*Postoffice*, Dixon Springs. *Location*, in the extreme southeastern portion of the state; northeast of Reevesville, 6 miles; north of Paducah, Ky., about 25 miles; east of Cape Giradeau, about 60 miles. *Situation*, on a spur of the Ozark Mountains, 1500 feet above sea level. *Access*, via Dixon Springs Station, on the Golconda Branch of the Illinois Central Railway, thence a short motor ride of $2\frac{3}{4}$ miles to the springs; and via motor over the national highways, passing through a wonderful picturesque region of great attractiveness, presenting picturesque scenic views at every turn of the roadway. *Hotels*, there is a comfortable hostelry, providing excellent accommodations. The hotel has a very large natatorium for the pleasure of guests, the swimming being much enjoyed. The waters from the famous Dixon Springs were known by the red man long before the advent of the white man. There are 9 springs in this area, and the following analyses on page 350 show the mineralization:

Spring No. 1, medicinal classification, very weak ferruginous or (− −Fe), radio-active.

Spring No. 2, medicinal classification, very weak ferruginous 0.5 or (− −Fe 0.5), strong radio-active.

Spring No. 3, medicinal classification, very weak ferruginous or (− −Fe), weak radio-active.

Spring No. 4, medicinal classification, very weak ferruginous or (− −Fe), weak radio-active.

Spring No. 7, medicinal classification, strong radio-active.
Spring No. 9, medicinal classification, radio-active.

DIXON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 7. | Spring No. 9. |
| Sodium chloride (NaCl) | 9.2 | 13.7 | 4.6 | 1.6 | 8.2 | 3.6 |
| Potassium chloride (KCl) | 7.1 | 3.6 | 6.7 | 8.4 | ... | 1.7 |
| Sodium sulphate ($Na_2SO_4$) | 14.8 | 14.8 | 21.9 | 24.1 | 3.4 | 3.4 |
| Magnesium sulphate ($MgSO_4$) | 90.0 | 69.7 | 65.7 | 70.2 | 6.9 | 2.5 |
| Ammonium sulphate ($[NH_4]SO_4$) | ... | 0.1 | 0.1 | | | |
| Calcium sulphate ($CaSO_4$) | 96.8 | 70.6 | 82.4 | 65.5 | 2.8 | 3.1 |
| Potassium nitrate ($KNO_3$) | ... | 4.1 | 0.7 | ... | 3.1 | |
| Sodium nitrate ($NaNO_3$) | ... | ... | ... | ... | 0.4 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 52.3 | 22.6 | 19.4 | 41.2 | 17.3 | 8.1 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 61.4 | 49.4 | 64.4 | 86.6 | 0.4 | 10.0 |
| Aluminum oxide ($Al_2O_3$) | 4.8 | 1.0 | 3.1 | 3.1 | 6.8 | 13.5 |
| Silica ($SiO_2$) | 10.8 | 9.8 | 8.9 | 10.8 | 19.7 | 52.2 |
| Bases | 0.5 | 1.0 | 1.1 | 0.2 | | |
| Total solids | 347.7 | 260.4 | 279.0 | 311.7 | 69.0 | 98.1 |
| Radio-activity, gm. per liter: | | | | | | |
| Uranium, $\times 10^{-4}$ | 18.20 | 86.10 | 4.90 | 4.00 | 67.00 | 13.00 |
| Radium, $\times 10^{-10}$ | 6.19 | 29.27 | 1.67 | 1.36 | 22.78 | 4.42 |

It will be observed from a careful study of the analyses that Springs No. 1, 2, 3 and 4 are lightly mineralized, calcic, magnesic, sodic, sulphated, calcic ferruginous bicarbonated alkaline-saline waters, carbondioxated, and all containing radio-active properties. Spring No. 7 is a slightly mineralized, calcic bicarbonated and sodic sulphated alkaline water, and Spring No. 9 is a slightly mineralized, calcic, sodic, sulphated saline water, both radio-active.

The waters from Dixon's Springs have long been highly endorsed by the profession for their valuable therapeutic properties, and value in the treatment of diseases of the stomach and intestines; in bladder and kidney affections; rheumatic and arthritic disorders and various skin affections. The management issues a leaflet containing endorsements from eminent members of the medical profession, who highly attest the virtues and curative properties of the various spring waters at Dixon's Springs; no more authoritative testimony of their value and usefulness can be offered.

## Gravel Springs.

(*Morgan County.*)

*Postoffice*, Jacksonville. *Location*, southwest of central Illinois; west of Springfield, the capital city, 35 miles; north of St. Louis, Mo., 80

miles. *Situation*, in a rolling prairie region, about 700 feet above sea level, surrounded by a fertile farming section of country well watered and well drained, healthful and salubrious. *Access*, via the Chicago & Alton Railways System. *Hotel*, good accommodations in Jacksonville. There are a number of springs in this area. The waters are bottled and sold commercially. The analysis below shows the mineralization:

GRAVEL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | |
|---|---|---|---|---|---|
| | Analyst, R. W. Stark. | | Analyst, A. R. Johnston. | | Analyst, A. L. Marsh. |
| | Dunlap Spring. | Seligman Spring. | Taylor Spring. | Carson Spring. | Ricks Spring. |
| Sodium chloride (NaCl) | 8.60 | 14.80 | 3.50 | ... | 4402.10 |
| Potassium chloride (KCl) | 1.70 | ... | 4.00 | | |
| Magnesium chloride ($MgCl_2$) | ... | ... | ... | 6.40 | |
| Potassium sulphate ($K_2SO_4$) | | | | | |
| Sodium sulphate ($Na_2SO_4$) | 21.30 | 14.90 | 19.20 | ... | 1.20 |
| Ammonium sulphate ($[NH_4]_2SO_4$) | 0.50 | | | | |
| Calcium sulphate ($CaSO_4$) | ... | ... | ... | 14.30 | |
| Magnesium sulphate ($MgSO_4$) | 12.10 | 6.00 | | | |
| Potassium nitrate ($KNO_3$) | 1.50 | 3.20 | 2.00 | 8.30 | 1.10 |
| Sodium nitrate ($NaNO_3$) | ... | 3.30 | ... | 22.50 | |
| Ammonium nitrate ($NH_4NO_3$) | ... | ... | 0.10 | 0.13 | |
| Magnesium nitrate ($Mg[NO_3]_2$) | ... | ... | 0.50 | 10.40 | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 118.53 | ... | 862.65 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 168.31 | 161.51 | 176.26 | 111.13 | 62.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 315.57 | 283.82 | 258.53 | 309.42 | 69.98 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.59 | 1.62 | 8.91 | 1.62 | 2.62 |
| Aluminum oxide ($Al_2O_3$) | 0.50 | 3.10 | 4.10 | ... | 3.30 |
| Silica ($SiO_2$) | 12.50 | 8.70 | 31.20 | 17.80 | 16.50 |
| Total solids | 545.17 | 500.95 | 626.82 | 502.00 | 5421.75 |

Dunlap Spring, medicinal classification, weak alkaline b or (−Ab).

Seligman Spring, medicinal classification, weak alkaline b or (−Ab).

Taylor Spring, medicinal classification, weak alkaline b or (−Ab).

Carson Spring, medicinal classification, weak alkaline b or (−Ab).

Rick's Spring, medicinal classification, weak alkaline a2, saline 2 or (−Aa2, Cl2).

All of these waters, with the exception of the Ricks Springs, may be classed as moderately mineralized, calcic and magnesic, bicarbonated, alkaline water. The Ricks Spring is a moderately highly mineralized sodic, muriated and bicarbonated, saline water, possessing diuretic and aperient properties, and should be useful in the treatment of stomach and intestinal disorders and in some types of hepatic disease. The water of the other springs possess diuretic and antacid properties, and are valuable table waters which are bottled and shipped extensively.

## Green Lawn Springs.

(*Jefferson County.*)

*Postoffice*, Mt. Vernon. *Location*, in southern Illinois; south of Springfield, the capital city, 110 miles; north of Paducah, Ky., 90 miles. *Situation*, in a rolling prairie and hilly wooded section of country, a considerable portion of which is found on elevated ridges. *Access*, via the Chicago, Rock Island & Pacific Railways System and the Louisville & Nashville Railway. *Hotel*, there are good hotels in the city, with modern conveniences. The springs are situated in a park in the heart of the city. The waters discharge from a vertical stratum of slate about 8 inches in width and bisecting a horizontal stratum of slate some several feet in thickness. A peculiarity of one of the springs is that the waters become turbid about the autumnal equinox, and another peculiarity attending these springs is that earthquake disturbances, though remote from the vicinity, produces the same turbidity of the waters; the water becomes reddish and remain so for a short period and then clears up, but for a while thereafter have a harsh acrid taste from an excess of alkaline ingredients. The analysis herewith shows the mineralization:

GREEN LAWN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Illinois Geological Survey). | | | |
|---|---|---|---|---|
| | Johnson Spring. | Plummer Spring. | Butler Spring. | Greene Spring. |
| Sodium chloride ($NaCl$) | 32.6 | 44.5 | 33.0 | 30.2 |
| Sodium sulphate ($Na_2SO_4$) | 273.6 | 283.9 | 49.9 | 282.8 |
| Magnesium sulphate ($MgSO_4$) | 340.5 | 552.4 | 21.6 | 266.4 |
| Ammonium sulphate ($[NH_4]SO_4$) | 6.9 | ... | ... | 4.8 |
| Aluminum sulphate ($Al_2[SO_4]_2$) | 76.6 | 227.0 | | |
| Calcium sulphate ($CaSO_4$) | 426.9 | 1085.6 | 41.6 | 312.6 |
| Ferrous sulphate ($FeSO_4$) | 61.8 | 73.6 | | |
| Potassium nitrate ($KNO_3$) | 5.4 | 12.7 | 11.6 | 32.8 |
| Sodium nitrate ($NaNO_3$) | ... | ... | 26.4 | 14.5 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 517.1 | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | ... | ... | 1184.4 | 117.7 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 26.0 | 2.9 | 10.9 |
| Aluminum oxide ($Al_2O_3$) | ... | ... | 2.4 | 5.3 |
| Silica ($SiO_2$) | 43.0 | 65.6 | 14.8 | 44.8 |
| Sulphuric acid, free ($H_2SO_4$) | 36.5 | | | |
| Total solids | 1310.8 | 2888.4 | 1388.6 | 1122.8 |

The Johnson Spring, medicinal classification, very weak acid sulphuric, weak sulphated 3 or (− −AcS, −S3). This is a moderately mineralized, ferric, calcic, magnesic, sodic sulphated acid (alumnic) water, possessing diuretic laxative and astringent properties.

The Plummer Springs, medicinal classification, combinations inconsistent. This is a moderately highly mineralized, calcic, magnesic, sodic, alumnic, sulphated saline water, possessing diuretic purgative and astringent properties.

The Butler Springs, medicinal classification, weak alkaline b3 or (−Ab3). This is a moderately mineralized calcic bicarbonated and sulphated, alkaline-saline water, possessing diuretic, antacid, laxative tonic and alterative properties.

The Greene Springs, medicinal classification, weak sulphated 2 or (−S2). This is a moderately mineralized calcic, magnesic, sodic, sulphated saline water, possessing diuretic, laxative and tonic properties. These waters are very efficacious in the treatment of dyspeptic disorders, inactivity of the liver biliousness and active disorders of the chylopoietic system.

## Min-Ni-Yan Springs.

(*Kendall County.*)

*Postoffice*, Bristol. *Location*, in northeastern Illinois, southwest of Chicago, 47 miles; northeast of Ottawa, 30 miles; south of Aurora, 20 miles. *Situation*, in a rolling prairie region, at an elevation of about 1000 feet above sea level. *Access*, via Bristol Station, on the main line of the Chicago, Burlington & Quincy Railway. *Hotel*, no definite information, but there are hotels in Bristol. The water percolates through peaty deposits, leaving a residue which can be used for mud and peat baths, similar to those at Mudlivia, Ind, Las Vegas, N. M., and at Byron Springs, Calif. The following analyses show the mineralization of some of the more important springs in this group:

MIN-NI-YAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Illinois Geological Survey). Spring No. 1. | Spring No. 2. | Spring No. 3. |
|---|---|---|---|
| Potassium chloride (KCl) | 3.5 | 5.0 | 3.4 |
| Sodium chloride (NaCl) | 3.3 | 5.1 | 4.9 |
| Sodium sulphate ($Na_2SO_4$) | 20.1 | 11.2 | 6.6 |
| Magnesium sulphate ($MgSO_4$) | 4.3 | 39.3 | 37.5 |
| Ammonium sulphate ($[NH_4]_2SO_4$) | 7.0 | 1.1 | 9.0 |
| Potassium nitrate ($KNO_3$) | 0.6 | 0.3 | 0.3 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 82.6 | 154.0 | 123.8 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 203.1 | 340.0 | 287.5 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 7.0 | 10.7 | 16.4 |
| Aluminum oxide ($Al_2O_3$) | 1.2 | 1.9 | 1.9 |
| Silica ($SiO_2$) | 16.0 | 18.8 | 16.8 |
| Total solids | 348.7 | 587.4 | 518.1 |

Springs 2 and 3, medicinal classification, weak alkaline b or (−Ab). The close similarity of the percentage of the predominating chemical constituents and total solids of all 3 springs permit of a single classifi-

cation: Moderately mineralized, calcic, magnesic, bicarbonated, alkaline (ferruginous) water, possessing diuretic and antacid properties, and should be useful in the treatment of gastric disorders due to acidity. The waters are said to exert a beneficial effect upon nervous disturbances of the renal and vesical apparatus. Hot baths with this water has favorably influenced rheumatism, painful swelling of the joints and in gouty affections.

## Montgomery Magnesia Springs.

*(Kane County.)*

*Postoffice*, Montgomery. *Location*, in northeastern Illinois; west of Chicago, 40 miles; east of Dixon, 60 miles; southeast of DeKalb, 25 miles. *Situation*, in a rolling prairie region, at an elevation of about 200 feet above tide water, surrounded by a fertile farming country. *Access*, via the Chicago, Burlington & Quincy Railway. *Hotel*, the place is not a resort, but the water is sold extensively. The analysis below shows the mineralization:

MONTGOMERY MAGNESIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Illinois Geological Survey). | | |
|---|---|---|---|
| | Caldwell Spring. | Templeton Spring. | Wells Spring. |
| Potassium chloride (KCl) | 9.0 | ... | 6.8 |
| Sodium chloride (NaCl) | 1.1 | 6.5 | |
| Potassium sulphate ($K_2SO_4$) | ... | 23.3 | 11.5 |
| Sodium sulphate ($Na_2SO_4$) | 27.0 | 26.0 | 196.9 |
| Potassium nitrate ($KNO_3$) | 0.6 | ... | 0.4 |
| Sodium bicarbonate ($NaHCO_3$) | 666.4 | 397.2 | 96.8 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 12.3 | 19.4 | 152.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 18.5 | 56.7 | 183.5 |
| Ammonium bicarbonate ($NH_4[HCO_3]_2$) | 2.1 | ... | 3.9 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 2.1 | 0.8 |
| Aluminum oxide ($Al_2O_3$) | 0.6 | ... | 0.2 |
| Silica ($SiO_2$) | 9.9 | 5.5 | 8.8 |
| Total acids | 747.5 | 536.7 | 662.3 |

Caldwell Spring, medicinal classification, weak alkaline a2 or (−Aa2). This is a moderately mineralized, sodic bicarbonated alkaline water, possessing diuretic and antacid properties.

Templeton Spring, medicinal classification, weak alkaline a or (−Aa). This is a moderately mineralized, sodic and calcic bicarbonated alkaline water, possessing diuretic and antacid properties.

Wells Spring, medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, sodic sulphated and magnesic and calcic bicarbonated alkaline-saline water, possessing diuretic and antacid properties.

## Perry Springs.

(*Pike County.*)

*Postoffice*, Mitton. *Location*, in western Illinois; west of Springfield, the capital city, 60 miles; southeast of Quincy, 40 miles; north of Griggsville, 9 miles. *Situation*, among a beautiful range of hills, on the west bank of the Illinois River, at an elevation of 1500 feet above sea level. *Access*, via the Wabash Railway to Griggsville or Perry Station, thence by motor 9 and 6 miles respectively to the springs. *Hotel*, this popular resort has good hotel accommodations; two hostelries offer all modern conveniences for comfort and pleasure. There are 3 springs. See analysis of the more important below:

PERRY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. W. Starke). |
|---|---|
| Sodium chloride ($NaCl$) | 13.2 |
| Sodium sulphate ($Na_2SO_4$) | 2.7 |
| Magnesium sulphate ($MgSO_4$) | 1.0 |
| Potassium nitrate ($KNO_3$) | 4.5 |
| Sodium nitrate ($NaNO_3$) | 2.8 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 145.9 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 253.0 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.4 |
| Aluminum oxide ($Al_2O_3$) | 2.0 |
| Silica ($SiO_2$) | 24.3 |
| Total solids | 452.8 |

Medicinal classification, weak alkaline b or (−Ab). The analysis shows this to be a moderately mineralized calcic, magnesic bicarbonated, alkaline water, possessing diuretic, antacid, tonic and alterative properties. It is said that this water has been used successfully in the treatment of gastric disorders due to acidity and in hepatic and kidney disorders.

## Sanicula Springs.

(*La Salle County.*)

*Postoffice*, Ottawa. *Location*, in northern Illinois; southwest of Chicago, 115 miles; east of Davenport, Iowa, 95 miles. *Situation*, in the valley of the Des Plaines River, at the head of the canal of the same name, at an elevation of about 800 feet above sea level. *Access*, Chicago, Rock Island & Pacific Railway System. *Hotel*, modern conveniences and appointments available. There are a number of springs, as shown by the following analyses;

SANICULA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | |
|---|---|---|---|---|---|
| | Analyst, R. W. Stark. | Analyst, A. D. Emmett. | | Analyst, J. M. Lindgreen. | |
| | Bruner Spring. | Large Spring. | Artesian Spring. | Jordan Spring. | Halm Spring. |
| Ammonium chloride ($NH_4Cl$) | ... | 14.8 | 11.4 | 12.4 | 10.2 |
| Potassium chloride (KCl) | 10.8 | ... | 70.8 | 41.2 | 18.3 |
| Sodium chloride (NaCl) | 14.5 | 9.8 | 1942.5 | 1091.6 | 26.8 |
| Calcium chloride ($CaCl_2$) | ... | 135.0 | 269.2 | ... | 95.2 |
| Sodium sulphate ($Na_2SO_4$) | 34.1 | ... | ... | ... | 16.5 |
| Ammonium sulphate ($[NH_4]_2SO_4$) | ... | ... | 5.4 | 4.2 | |
| Magnesium sulphate ($MgSO_4$) | ... | 4.2 | 423.1 | 257.5 | |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | 4.3 | 0.4 | | |
| Ferrous sulphate ($FeSO_4$) | ... | ... | ... | 5.6 | |
| Potassium nitrate ($KNO_3$) | 0.3 | 10.7 | 1.1 | 0.9 | 0.4 |
| Sodium nitrate ($NaNO_3$) | ... | 12.4 | | | |
| Sodium bicarbonate ($NaHCO_3$) | 27.0 | ... | ... | ... | 92.9 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 184.0 | | | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 287.2 | ... | ... | 300.5 | |
| Aluminum oxide ($Al_2O_3$) | ... | 2.1 | 1.6 | ... | 1.7 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.6 | 215.6 | 310.4 | 187.3 | 159.9 |
| Silica ($SiO_2$) | 7.9 | | | | |
| Total solids | 564.4 | 408.9 | 3034.3 | 1901.2 | 421.9 |

The Bruner Spring, medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic, sodic, bicarbonated alkaline water, possessing diuretic and antacid properties.

The Large Spring is a moderately mineralized, calcic, muriated, ferruginous water, possessing diuretic and tonic properties.

The Artesian Spring is a moderately highly mineralized, sodic, muriated, magnesic sulphated, ferruginous, saline water, possessing diuretic, slight laxative and tonic properties.

The Jordan Spring is a moderately highly mineralized, sodic, muriated, magnesic and calcic sulphated and bicarbonated saline (ferruginous) water, possessing diuretic, antacid, laxative and tonic properties.

The Halm Spring is a moderately mineralized, ferruginous, sodic, bicarbonated, calcic potassic muriated alkaline-saline water, possessing diuretic, antacid, tonic and alterative properties.

The following springs have been used as resorts:

*Cumberland Mineral Springs, P. O.*, Greenap, Cumberland County. Once used as a resort. No definite information nor satisfactory analysis available.

*Hygienic Springs, P. O.*, Western Saratoga, Union County. These springs had quite a reputation three or four decades ago. The hotel buildings were later destroyed, and the placed passed into apparent obscurity. No definite information nor satisfactory analysis available.

*Sailor Springs, P. O.*, Sailor Springs, Clay County. Once a resort. No definite information nor satisfactory analysis available.

*Versailles Springs, P. O.*, Versailles, Brown County. There are 4 springs in this area. Once a popular resort. No definite information nor satisfactory analysis available; abandoned.

*Zonian Springs, P. O.*, Elgin, Kane County. Once renowned for the curative properties of the waters in kidney, stomach and liver troubles. No definite information nor satisfactory analysis available.

The following springs reported the commercial sale of water during 1924:

*Abana Mineral Spring, P. O.*, Libertyville, Lake County.
*Aurora Lithia Springs, P. O.*, Montgomery, Kane County.
*Indian Springs, P. O.*, La Salle, La Salle County.
*Minerva Mineral Spring, P. O.*, Cary, McHenry County.
*Na-Mo-Na Spring, P. O.*, Dixon Springs, Pope County.
*Old Ironsides, P. O.*, Dixon Springs, Pope County.
*Ripley Mineral Springs, P. O.*, Ripley, Brown County.
*Woodman Artesian Well, P. O.*, Rock Island, Rock Island County.

## INDIANA.

Indiana extends from 37°51′ to 41°46′ north latitude and from 85°48′ to 88°1′ west longitude, and embraces an area of 38,809 square miles, of which 440 square miles are inundated. Lying within the prairie region, it has a gentle undulating surface, which slopes by imperceptible stages toward the southwest. The northwestern portion has an elevation of about 500 to 700 feet and the northeastern portion has an elevation of 1200 feet. The climate is salubrious, and is somewhat milder than is experienced in the same latitudes further east. The winters are cold, but not excessively long in duration, and the summers are often very hot and depressing. The mean annual temperature at Indianopolis is 10.5° C. (51° F.); cold northerly winds lower the winter temperature to 4.8° C. (25° F.).

Indiana has 101 spring localities, with a total of 151 individual springs, 28 of which have been analyzed and 6 of which at various times been used as resorts. The geological formation being similar to the neighboring states, we find that the springs are also similar, and, as in Ohio, Illinois and Kentucky, the sulphuretted and chalybeate waters predominate. Mineral springs are quite numerous in this state, but few of them have achieved much reputation, and many have never been improved. Seven reported water sales during the year 1923. French Lick Springs and West Baden are the most popular places of resort; both have modern hotels and bathing establishments. Repeated inquiries and personal letters to spring owners have failed to yield information pertaining to many places mentioned as resorts in the older works. The list presented here is not complete,

but we feel that it is fairly representative of the active springs and spas in use today. The author acknowledges many courtesies extended by Mr. T. M. Kingsbury, Assistant State Geologist.

## Allendale Mineral Springs.

*(Putnam County.)*

*Postoffice*, Greencastle. *Location*, in the midwestern portion of the state; west of Indianapolis, the capital city, 40 miles; northeast of Terre Haute, 35 miles. *Situation*, in the midst of a beautiful valley. *Access*, via the Pennsylvania Railway, Main Line, N. Y., to St. Louis, New York Central Railway, N. Y., to Cleveland, Monon route, Chicago to Louisville, thence to springs, not more than 1 mile from any station. *Hotel*, guests accommodated during the summer resort season. There are 5 springs, all within a small radius. The analysis below shows the mineralization:

ALLENDALE MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Indiana Geological Survey). Daggy Spring. | Dewdrop Spring. |
|---|---|---|
| Potassium chloride (KCl) | 1.6 | 1.4 |
| Sodium chloride (NaCl) | 12.3 | 10.8 |
| Sodium sulphate ($Na_2SO_4$) | 6.1 | 4.6 |
| Magnesium sulphate ($MgSO_4$) | 14.8 | 15.3 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 148.3 | 161.5 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 392.3 | 329.5 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 10.4 | 62.8 |
| Aluminum oxide ($Al_2O_3$) | 2.7 | 1.3 |
| Silica ($SiO_2$) | 1.5 | 0.1 |
| Total solids | 585.3 | 587.1 |
| Gases: | | |
| Carbon dioxide, cc. per liter | 13.0 | 12.9 |

Daggy Spring and Dewdrop Spring, medicinal classification, weak alkaline b or (−Ab). The analyses of the Daggy and Dewdrop Springs show a moderately mineralized, calcic, magnesic, bicarbonated alkaline water, possessing diuretic, antacid and valuable tonic properties, particularly the Dewdrop Spring, which carries 62.8 mg. of iron bicarbonate per liter. These springs, in the percentage of the chemical constituents, closely resemble the celebrated European springs at Baden Baden and Stahlbrunen. These waters are highly endorsed by the profession in the treatment of disorders of the stomach and in affections of the genito-urinary tract and particularly in anemia, general debility and in all run-down conditions where an iron tonic is indicated, particularly in all depraved conditions of the blood and blood-making organs.

## French Lick Springs.

(*Orange County.*)

*Postoffice*, French Lick. *Location*, near the southern border of the state; south of Indianapolis, 75 miles; west of Cincinnatti, O., 140 miles; east of St. Louis, Mo., 190 miles; northwest of Louisville, Ky., 50 miles. *Situation*, in a beautiful valley through which flows the Lost River and the French Lick Creek, near the banks of the latter, at an elevation of 500 feet above sea level, the great French Lick Springs gush forth. *Access*, via French Lick Station, situated within the grounds, and on the main line of the Monon route and the Southern Railway; through sleepers from all points. *Hotels*, there is a large commodious structure, six stories high, of fireproof, brick construction, with 650 bed chambers, single and ensuite, with all modern conveniences. A large addition *de luxe* of 105 rooms has recently been added; the whole most luxuriously furnished and equipped; with a large convention hall. The bathing establishment is in perfect harmony with the general excellence of the hotel. Special departments are provided for both men and women; all so well arranged that guests can reach the baths without leaving the hotel. The baths are equipped with the most approved modern hydrotherapeutic apparatus for the scientific application of balneotherapy in all its branches—Turkish, Russian and Roman baths, electric baths, Nauheim baths, packs, rubs and fomentations. The springs emerge from crevices in the Chester limestone at the point of junction of that formation with the overlying Mansfield sandstone. The mineralization of the waters is shown in the following analyses:

FRENCH LICK SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, H. E. Barnard, Ph.D., Indiana Board of Health). | | | |
|---|---|---|---|---|
| | Pluto Spring. | Bowles Spring. | Prosperine Spring. | Pluto concentrated. |
| Ammonium chloride ($NH_4Cl$) | 31.2 | 26.8 | 32.7 | 17.1 |
| Potassium chloride (KCl) | 31.5 | 28.6 | 16.2 | 33.5 |
| Sodium chloride (NaCl) | 1688.5 | 1285.9 | 1539.8 | 2054.2 |
| Magnesium chloride ($MgCl_2$) | 77.5 | ... | 51.8 | |
| Magnesium sulphate ($MgSO_4$) | 1051.5 | 877.5 | 1032.2 | 34,536.4 |
| Sodium sulphate ($Na_2SO_4$) | ... | 285.8 | ... | 62,843.7 |
| Calcium sulphate ($CaSO_4$) | 1388.9 | 921.1 | 1379.6 | 1507.1 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 379.5 | 373.4 | 325.6 | 323.9 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 5.0 | 3.0 | 16.00 | 16.0 |
| Silica ($SiO_2$) | 28.0 | 21.0 | 13.0 | 13.0 |
| Total solids | 4681.6 | 3824.9 | 4413.1 | 101,344.9 |
| Gases: | | | | |
| Carbon dioxide, free ($CO_2$) cc. per liter | 131.0 | 110.0 | 102.0 | |
| Hydrogen sulphide ($H_2S$) cc. per liter | 30.5 | 20.3 | 18.0 | |
| Radio-activity, Mache units per liter | 1.35 | 4.45 | 1.96 | |

The combined flow of the 3 springs is about 1100 gallons per minute, and the flow is constant, running at this rate without change for many years.

Pluto Spring, medicinal classification, saline, sulphated or (Cl, S), carbon-dioxated, sulphuretted, very weak radio-activated. This is a moderately highly mineralized, sodic, muriated, magnesic, calcic, sulphated saline water, carbon-dioxated, sulphuretted, radio-activated, possessing diuretic, antacid and purgative properties.

Bowles Spring, medicinal classification, weak saline 3, sulphated (−Cl 3, S), carbon-dioxated, sulphuretted, weak radio-active. This is a moderately highly mineralized, sodic, muriated, magnesic, calcic, sulphated, saline water, carbon-dioxated, sulphuretted, radio-activated, possessing diuretic, antacid and purgative properties.

Prosperine Spring, medicinal classification, weak saline 4 sulphated or (−Cl 4, S), carbon-dioxated, sulphuretted, very weak radio-active. This is a moderately highly mineralized, sodic, muriated, calcic, magnesic, sulphated saline water, carbon-dioxated, sulphuretted, radio-activated, possessing diuretic, antacid and purgative properties.

Pluto Concentrated Water, medicinal classification, very strongly sulphated or (++S2). This is a very highly concentrated, sodic, magnesic sulphated saline water.

It will be noted on carefully examining the analyses of the 3 springs that there is a great similarity in the percentage of the predominating chemical constituents, all belonging to the sodic, magnesic, sulphated saline types of water. They are all valuable eliminants, and radio-active to a marked degree. The waters are all clear, cool and have a odor of sulphuretted hydrogen, and are slightly bitter to the taste, due to the magnesium and sodium sulphates, the predominating elements in the chemical constituents of the waters. The waters have a wide range of usefulness in gastric and intestinal disorders, auto-intoxication, and diseases of the liver, gall-bladder and ducts; obesity and diseases of the bladder and kidneys. The medical profession endorse and prescribe these waters with satisfaction. The radio-activity with which these waters are charged add to their therapeutic properties and to the physiological effects on tissue oxidation and metabolism. The sulphur baths are a distinctive feature, by reason of their mineralization, and contained gas; they produce a stimulating effect on the nerve endings of the skin and exert a healing, soothing action on the outer layers of the integumentary system, which is of great value in the treatment of many skin affections.

The French Lick Springs are by far the oldest and best-known springs in Indiana. Their history long antedates the coming of the white man. The aboriginal inhabitants of the region were the Miamis and the Piankeshaws, but various members of other tribes came to the "lick" to drink, the healing waters. The French of Vincennes were the first white settlers, being in quest of salt, and a salt depot was attempted by them, but was destroyed by the hostile Indians.

Besides the magnificent hotel and luxurious baths, the charming scenery and delightful climate, there are many attractions around French Lick; riding and driving are popular amusements, excellent riding and driving horses being available; here are two of the best golf courses in the country, with a new golf club house, providing every comfort and convenience for the golf enthusiast. Among the indoor sports are billiards, bowling, pool and indoor golf.

The medical department of the institution is well provided for and resident in the hotel—all the advantages of a high-class sanitarium without being a sanitarium. A scientific department, embracing completely equipped chemical and bacteriological laboratories, is maintained in the bottling plant, both departments coöperating to supervise the health and sanitation of the establishment—the testing of all foods, milk, cream, etc., served in the hotel. (See also Chapter XV.)

### Indiana Springs and Mud Baths.

(*Warren County.*)

*Postoffice*, Kramer. *Location*, in western Indiana; northwest of Indianapolis, the capital city, 87 miles; southwest of Logansport, 60 miles; north of Terre Haute, 75 miles. *Situation*, at the base of a wooded ridge, whose crest is 50 feet above the point of issue of the springs, which is at an elevation of about 750 feet above tide water. *Access*, via the Chicago & Eastern Illinois Railway to Attica, thence a distance by motor 4 miles to the springs. *Hotel*, there is a large and commodious hostelry, with modern improvements and conveniences. There is an excellent bathing establishment modern in construction and equipment, fitted especially for administering the celebrated "mud baths," for which the resort has become famous. As many as 200 patients can be accommodated in one day. The water of the springs comes from the bosom of Mother Nature sparkling with carbonic-acid gas, pleasing and potable. At the foot of the ridge below the springs is a large deposit of inky-black muck or mud formed from decayed vegetation into which the seepage of the springs for centuries had deposited the mineral constituents of the waters. This mud is now excavated and transported to the bathrooms heated by steam, and the temperature controlled to the right degree for the famous mud baths. The analysis below shows the mineralization.

INDIANA SPRINGS AND MUD BATHS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Stackder). |
|---|---|
| Potassium chloride (KCl) | trace |
| Sodium chloride (NaCl) | 5.68 |
| Calcium sulphate ($CaSO_4$) | 31.73 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 303.53 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 103.01 |
| Silica ($SiO_2$) | 16.53 |
| Total solids | 460.48 |
| Gases: | |
| Carbon dioxide, free, cc. per liter | 10.7 |

Medicinal classification, weak alkaline b or (−Ab). The analysis shows this to be a moderately mineralized, calcic, magnesic, bicarbonated, alkaline water, possessing diuretic, antacid and aperient properties. The inky-black mud on analysis shows the presence of silica, ferric oxide, aluminia, calcium, magnesium, potassium and sodium. Baths with this mud are claimed to be exceedingly efficacious in the treatment of obstinate rheumatic and chronic articular disease, gout and chronic eczema. The "drinking cure" with the water is beneficial in kidney and bladder troubles.

### King's Mineral Springs.

*(Clark County.)*

*Postoffice,* Dallas. *Location,* in southeastern Indiana; southeast of Indianapolis, the capital city, 100 miles; north of Louisville, Ky., 18 miles; north of Jeffersonville, the county seat, 15 miles. *Situation,* in an undulating region, well-drained, healthful and salubrious. The elevation is about 700 feet above sea level. *Access,* via the Monon route. *Hotel,* no definite information as to the class of accommodations. The spring arises from the New Providence shale which gives the water a bitter taste, due to the sulphate evolved from the Knobstone formation. The analysis shows the following mineralization:

KING'S MINERAL WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. A. Noyes). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 2860.21 |
| Potassium sulphate ($K_2SO_4$) | 169.88 |
| Sodium sulphate ($Na_2SO_4$) | 3233.17 |
| Magnesium sulphate ($MgSO_4$) | 7976.71 |
| Calcium sulphate ($CaSO_4$) | 956.52 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 704.58 |
| Silica ($SiO_2$) | 11.15 |
| Total solids | 15,512.20 |

Medicinal classification, saline, strong sulphate or (Cl, +S). This is a highly mineralized, sodic, muriated, magnesic, potassic, sulphated, saline water, possessing purgative properties when taken in proper dosage, but in smaller amounts it is said to be of value in the treatment of disorder of the stomach and bowels.

### Martinsville Mineral Wells.

*(Morgan County.)*

*Postoffice,* Martinsville. *Location,* southwest of central Indiana; southwest of Indianapolis, the capital city, 30 miles; west of Cincinnati, O., 130 miles. *Situation,* the town is situated on the west fork of the White River, and lies at the foot of a range of wooded hills of varied and interesting topographical features. *Access,* via the I. & V.

branch of the Pennsylvania Railway System. *Hotels*, the hotel is a large commodious structure, with modern conveniences. The bathing department is modern in construction and equipment, with every facility for mineral, vapor and electric-light baths.

The Home Lawn Sanitarium and Hotel consists of 3 buildings, 2 brick and 1 frame, connected by wide enclosed steam-heated and electric-lighted corridors. One of the buildings is fitted up as a bathing establishment, with all modern equipment for the scientific practice of balneotherapy. The middle brick building is the main hotel, where all the latest conveniences are at hand for comfort of guests.

The Highland Hotel and Sanitarium is a three-story building, modern in construction and equipment, with every facility for hydrotherapy and balneotherapy.

The National Hotel and Sanitarium is a commodious two-story frame building, with every convenience for hotel and sanitarium accommodations.

The Barnard Sanitarium is a two-story frame structure, used chiefly as a bathing establishment, with private rooms for the accommodations of permanent guests.

The wells on analyses show the following mineralization:

MARTINSVILLE MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analyst, W. E. Stone. | | Analyst, J. N. Hurty. | Analyst, T. C. Van Nuys. |
| | Martinsville Sanitarium Well. | Home Lawn Well. | Forest Park Well. | Barnard Well. |
| Potassium chloride ($KCl$) | 30.34 | 252.72 | 26.65 | 350.29 |
| Sodium chloride ($NaCl$) | 1001.71 | 954.22 | 756.65 | 313.95 |
| Magnesium chloride ($MgCl_2$) | ... | ... | 145.17 | 128.28 |
| Calcium chloride ($CaCl_2$) | ... | ... | 542.18 | 173.06 |
| Potassium sulphate ($K_2SO_4$) | ... | ... | ... | 15.33 |
| Sodium sulphate ($Na_2SO_4$) | 32.13 | 29.01 | | |
| Potassium sulphide ($K_2S$) | ... | ... | 12.19 | |
| Sodium sulphide ($Na_2S$) | ... | ... | 9.11 | 18.65 |
| Calcium sulphide ($CaS$) | ... | ... | 8.55 | |
| Sodium bicarbonate ($NaHCO_3$) | 68.75 | 90.64 | 63.49 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 325.47 | 148.21 | 50.38 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 468.22 | 181.58 | 117.63 | 203.47 |
| Aluminum oxide ($Al_2O_3$) | 11.30 | 17.05 | | |
| Silica ($SiO_2$) | 9.50 | 144.59 | | |
| Total solids | 1917.42 | 1818.02 | 1732.00 | 1202.03 |
| Gases: | | | | |
| Carbon dioxide, free, cc. per liter | 73.0 | 157.0 | 165.5 | 79.5 |
| Hydrogen sulphide, cc. per liter | 2.4 | 23.8 | 195.2 | 3.5 |

The Martinsville Sanitarium Well, medicinal classification, weak alkaline b2, weak saline 3 or (−Ab2, −Cl 3), sulphuretted. This is a moderately highly mineralized, sodic, muriated and calcic magnesic, bicarbonated alkaline-saline water, carbon-dioxated, sulphuretted, possessing diuretic, antacid, aperient and tonic properties.

The Home Lawn Well, medicinal classification, weak alkaline b, weak saline 3 or (−Ab, −Cl 3), sulphuretted, carbon-dioxated. This is a moderately highly mineralized, sodic muriated, bicarbonated, alkaline-saline water, carbon-dioxated, sulphuretted, possessing diuretic, antacid, aperient and tonic properties.

Forest Grove Park Well, medicinal classification, weak saline 4 or (−Cl 4), carbon-dioxated, sulphuretted. This is a moderately highly mineralized, sodic, calcic magnesic muriated and calcic sodic, bicarbonated saline water, carbon-dioxated, sulphuretted, possessing diuretic, antacid and aperient properties.

Barnard Well, medicinal classification, weak saline 2 or (−Cl 2), sulphuretted. This is a moderately mineralized, potassic, sodic, magnesic, calcic muriated saline water, carbon-dioxated, sulphuretted, possessing diuretic and aperient properties.

## Paoli Mineral Springs.

*(Orange County.)*

*Postoffice,* Paoli. *Location,* in southern Indiana; south of Indianapolis, the capital city, 75 miles; west of Cincinnati, O., 140 miles; east of St. Louis, Mo., 200 miles. *Situation,* in a rolling region, at an elevation of about 700 feet above sea level. *Access,* via the French Lick branch of the Monon route; good train service. *Hotel,* there is a three-story brick and stone structure, with modern accommodations. A well-equipped bathing establishment in connection with the hotel offers every opportunity for baths of all types. The springs' (wells) analyses below show the mineralization:

PAOLI MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, W. A. Noyes.) Lithia Spring. | (Analyst, C. B. Stout.) Gas Well. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | ... | 81.34 |
| Potassium chloride (KCl) | 40.42 | |
| Sodium chloride (NaCl) | 2059.40 | 10,508.58 |
| Ferric chloride ($FeCl_3$) | ... | 4.00 |
| Calcium chloride ($CaCl_2$) | ... | 3,159.26 |
| Magnesium chloride ($MgCl_2$) | 75.14 | 2,555.32 |
| Magnesium sulphatë ($MgSO_4$) | 891.55 | 2,183.53 |
| Calcium sulphate ($CaSO_4$) | 1729.22 | 177.30 |
| Magnesium nitrate ($Mg[NO_3]_2$) | ... | 25.75 |
| Lithium bicarbonate ($LiHCO_3$) | 27.87 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 565.95 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.29 | 73.96 |
| Sodium silicate ($Na_2SiO_3$) | ... | 1,201.58 |
| Aluminum oxide ($Al_2O_3$) | 2.57 | |
| Silica ($SiO_2$) | 12.77 | |
| Total solids | 5409.18 | 20,054.15 |

The Lithia Spring, medicinal classification, saline, sulphated or (Cl, S). This is a moderately highly mineralized, calcic, magnesic, sulphated and bicarbonated, alkaline-saline water, possessing diuretic, antacid, purgative and solvent properties.

The Gas Well, medicinal classification, strong saline 2, sulphated or (+Cl 2, S). This is a highly mineralized, sodic, calcic, magnesic, muriated, sulphated, saline water, possessing diuretic, laxative, tonic and alterative properties.

## Trinity Springs.

(*Martin County.*)

*Postoffice*, Trinity Springs. *Location*, in the southwestern portion of the state; south of Indianapolis, the capital city, 80 miles; northwest of Louisville, Ky., 70 miles; east of Vincennes, 40 miles. *Situation*, in Trinity Springs Park, covering 10 acres and occupying a terraced elevation facing Indian Creek, and which lies between the springs and that stream, at an elevation of 7700 feet above sea level. *Access*, via the Indian Springs Station, on the Chicago, Milwaukee & St. Paul Railway, thence by motor 2 miles to the springs, and via Shoals Station, on the Baltimore & Ohio Southwestern, thence by motor 8 miles to the springs. *Hotel*, there is a large commodious brick structure, with modern conveniences, home-like and comfortable. A modern bathing establishment is in course of construction, which will be equipped with the latest approved apparatus for the scientific application of hydrotherapy and balneotherapy in the treatment of disease. The Trinity Springs, so-called for their number, are among the oldest and best-known sulphur springs in the state. The springs well up from rifts or crevices in the Mansfield sandstone rock back of the park. To the east of the springs is a finely wooded ridge of native forest trees. Two of these springs are but 8 feet apart, and the other about 20 feet to the south. The middle spring flows about 50 gallons per minute, the springs to the north about 10 gallons per minute and the output of the southern springs is 30 gallons per minute. The waters are clear, the odor of hydrogen sulphide is quite marked; the taste is not unpleasant, but slightly bitter and sulphuretted. The following analysis shows the mineralization:

TRINITY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, T. C. Van Nuys). |
|---|---|
| Potassium chloride ($KCl$) | 70.3 |
| Sodium chloride ($NaCl$) | 204.1 |
| Sodium sulphate ($Na_2SO_4$) | 103.4 |
| Magnesium sulphate ($MgSO_4$) | 607.5 |
| Calcium sulphate ($CaSO_4$) | 1378.5 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 365.1 |
| Calcium silicate ($CaSiO_3$) | 32.0 |
| Total solids | 2750.9 |
| Gases: | |
| Hydrogen sulphide, cc. per liter | 7.45 |
| Carbon dioxide, cc. per liter | 25.00 |

Medicinal classification, weak alkaline b, sulphated or (−Ab, S), sulphuretted. The analysis shows this to be a moderately highly mineralized, calcic, magnesic, sodic, sulphated and sodic, muriated saline water, sulphuretted, possessing diuretic and laxative properties. The water has long been endorsed by the profession in the treatment of digestixe disorders due to acidity and in sluggish action of the intestinal tract, disorders of the bladder and kidneys, rheumatism and the uric-acid diathesis.

## West Baden Springs.

(*Orange County.*)

*Postoffice*, West Baden. *Location*, near the southern border of the state; south of Indianapolis, the capital city, 75 miles; east of St. Louis, Mo., 190 miles; west of Cincinnati, O., 140 miles. *Situation*, in the Lost River Valley, through which flows French Lick Creek, and near its banks, at an elevation of 500 feet above sea level, a number of springs break through a fault or fissure charged with curative properties compounded in Nature's laboratory. *Access*, via West Baden Station, on the Chicago, Indianapolis & Louisville Railway, thence only a short distance to the springs, and by motor over the great national highways which intersect this region. *Hotel*, there are accommodations for 1000 guests, ranging from luxurious suites with marbled baths to small, simply furnished, single rooms; comfort has been installed throughout the entire building. The hotel contains a convention hall, with a seating capacity for 1200 people. There is a colossal inner court, known as the Pompeian Room, which embraces 40,000 square feet of marble flooring, forming a great indoor garden. The bath department occupies an entire floor of the hotel. The equipment, recently installed at a cost of more than $200,000, is modern in every particular. Every type of bath is given, including the famous sulphur and hot-sulphur mud baths, one of the very few places in this country where the latter is obtainable.

A unique feature of the institution recently established is a high-class medical and surgical department, which occupies the entire sixth floor of the hotel. This is in charge of physicians of recognized ability. There has been installed the latest and most approved type of equipment for the operating and sterilizing rooms. The medical and surgical staff consists of a personnel of 25, including physicians, surgeons, assistants, nurses, technicians, dieticians, masseurs, etc. The roentgen-ray laboratory is a complete unit. The chemical and bacteriological laboratories are coördinating units of the medical and surgical division. A special diet kitchen, apart from the hotel dining room, is maintained, where special menus are prepared for the individual needs of the patients.

There are a number of springs in the area, of which the following have

been improved by excavating larger circular basins, 6 to 10 feet in depth, with cemented floors and walls. The following analyses show the mineralization of 4 of the springs:

WEST BADEN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analyst, Hoskins. | | Analyst, E. T. Cox. | Analyst, W. A. Noyes |
| | Spring No. 1. | Spring No. 3. | Spring No. 5. | Spring No. 7. |
| Lithium chloride (LiCl) | trace | | | |
| Sodium chloride (NaCl) | 1700.60 | 2186.82 | ... | 1264.50 |
| Potassium chloride (KCl) | ... | 212.29 | 1337.18 | 64.50 |
| Magnesium chloride ($MgCl_2$) | 233.06 | 132.57 | 195.54 | 224.04 |
| Calcium chloride ($CaCl_2$) | 12.56 | ... | 124.78 | 134.30 |
| Sodium bromide (NaBr) | trace | ... | trace | trace |
| Sodium iodide (NaI) | trace | ... | trace | trace |
| Sodium sulphate ($Na_2SO_4$) | 40.27 | 240.25 | 53.28 | 52.60 |
| Potassium sulphate ($K_2SO_4$) | 28.10 | ... | 23.48 | 14.41 |
| Magnesium sulphate ($MgSO_4$) | 471.93 | 916.04 | 619.83 | 781.50 |
| Calcium sulphate ($CaSO_4$) | 229.46 | 746.02 | 191.70 | 1962.50 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 92.49 | ... | 77.28 | 43.99 |
| Sodium bicarbonate ($NaHCO_3$) | 36.99 | 288.18 | 30.90 | 268.33 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1302.09 | 1485.61 | 1087.79 | 891.98 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1075.68 | 865.24 | 1149.27 | 954.70 |
| Potassium bicarbonate ($KHCO_3$) | ... | ... | 17.35 | 17.59 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | ... | ... | trace | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 58.83 | ... | 81.58 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | ... | ... | ... | trace |
| Ferric oxide ($Fe_2O_3$) | 1.79 | ... | 1.50 | |
| Silicic acid ($H_2SiO_3$) | 8.97 | ... | 7.50 | |
| Silica ($SiO_2$) | ... | ... | ... | 7.60 |
| Total solids | 5233.99 | 7131.85 | 4917.38 | 6664.12 |
| Gases: | | | | |
| Carbon dioxide (free), calculated to satisfy bases | | | | |
| Carbon dioxide on evaporation to dryness, cc. per liter | 34.2 | 28.6 | 19.4 | 35.8 |
| Oxygen | 27.3 | 14.1 | 6.2 | 27.9 |
| Nitrogen | 102.5 | 89.4 | ... | 96.2 |
| Sulphuretted hydrogen | ... | ... | ... | 45.5 |
| Flow in gallons per day | 4320 | ... | 8640 | 17,280 |

Spring No. 1, medicinal classification, alkaline b, saline, weak sulphated 2 or (Ab, Cl, −S2), azotized. This is a moderately highly mineralized, sodic, muriated and calcic and magnesic bicarbonated alkaline-saline water, azotized, possessing diuretic, antacid, slight laxative, tonic and alterative properties.

Spring No. 3, medicinal classification, alkaline b, saline, sulphated or (Ab, Cl, S). This is a highly mineralized, sodic, muriated, magnesic

and calcic, sulphated, alkaline-saline (ferruginous) water, azotized, possessing antacid, diuretic, laxative and tonic properties.

Spring No. 5, medicinal classification, alkaline b, weak saline 4, weak sulphate 2 or (Ab, −Cl 4, −S2). This is a moderately highly mineralized, calcic and magnesic bicarbonated and potassic muriated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, tonic, alterative and aperient properties.

Spring No. 7, medicinal classification, alkaline b, saline, sulphated or (Ab, Cl, S), sulphuretted. This is a moderately highly mineralized, sodic and calcic, muriated and sulphated alkaline-saline (ferruginous) water, sulphuretted, azotized and possessing diuretic, laxative and tonic properties.

The predominating chemical constituents in all of these waters are quite similar in percentage proportions, and possess similar therapeutic properties. The waters are well and favorably known, and have the endorsement of the leading members of the profession, and are used with success in a wide range of diseases: Spring No. 1 in inflammations of the genito-urinary tract, stone in the kidney and bladder; Spring No. 3 in anemia, chlorosis, nervous debility, insomnia, neuralgia, hysteria, etc.; Spring No. 5 is very high in potassic chloride, a valuable alterative in rheumatism and rheumatic joint disturbances, scrofula, etc.; Spring No. 7 promotes the easy and painless removal of waste products from the system, bowels, kidneys, liver, etc.

For more than a century the healing virtues of these waters have been known to the white man, and for centuries before, the red men of the forest knew of and appreciated the "healing waters" of these now famous springs. West Baden, now one of the famous spas of this country, offers every advantage to be found at any of the great spas of the world; the department of hydrotherapy and balneotherapy, supervised by a competent hydrologist, offers every opportunity for health-building to be found at any of the European resorts. The climatic conditions are ideal and the whole atmosphere of the resort home-like and pleasing. (See also Chapter XV.)

## White Crane Mineral Springs.

(*Dearborn County.*)

*Postoffice*, Dillsboro. *Location*, in the southeast corner of the state; southwest of Cincinnati, O., 33 miles; southeast of Indianapolis, about 100 miles; northeast of Louisville, Ky., about 70 miles. *Situation*, on a beautiful plateau, the highest point between St. Louis, Mo., and Cincinnati, O., 1000 feet above sea level. *Access*, via Dillsboro Depot, on the main line of the Baltimore & Ohio Railway, thence by motor 1 mile to the sanitarium. *Hotel*, the sanitarium is a new structure, with modern conveniences, of 105 rooms. The bathing department of the sanitarium is fully equipped for the scientific

administration of hydrotherapeutic treatments; roentgen-ray and electrotherapy departments are all under the supervision and direction of a competent diagnostician with trained assistants. The mineralization of the water is shown in the analysis given herewith:

WHITE CRANE MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Charles T. P. Fennel, 1924). |
|---|---|
| Sodium chloride ($NaCl$) | 2,139.0 |
| Calcium chloride ($CaC_2l$) | 931.5 |
| Magnesium chloride ($MgCl_2$) | 2,300.0 |
| Sodium sulphate ($Na_2SO_4$) | 3,588.0 |
| Magnesium sulphate ($MgSO_4$) | 862.5 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 931.5 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 805.0 |
| Total solids | 11,557.5 |
| Gases in solution: | |
| Hydrogen sulphide | 750.0 |

Medicinal classification, saline 3, sulphate 3 or (Cl 3, S3), sulphuretted. This is a highly mineralized, sodic magnesic sulphated saline water, sulphuretted, flowing at the rate of 50,000 gallons per day and possessing purgative eliminative properties and has proven of value in the relief of rheumatic and arthritic disturbances, neuritis, neurasthenia, constipation and disorders of the gastro-intestinal tract. The sanitarium is conducted as an all-year round resort and is equipped with every modern convenience for the scientific care of guests.

The following springs were once used as resorts:

*Indian Spring P. O.*, Indian Springs, Martin County. This place was a resort as early as 1814, and at one time enjoyed quite a reputation. The water belongs to the alkaline-saline chalybeate class. Repeated correspondence failed to elicit the necessary information or a satisfactory analysis. No doubt the development of two world-wide known health resorts in the state has detracted from the former popularity of this place.

*Kickapoo Magnetic Springs, P. O.*, Kickapoo, Warren County. It is said this spring was discovered as early as 1750. This is a calcic, magnesic bicarbonated, alkaline water. Repeated letters failed to secure the necessary information or a satisfactory analysis. Postmaster returns letters marked "unknown."

*Lodi Artesian Well, P. O.*, Lodi, Fountain County. This is a strong saline sulphuretted water. No definite information nor satisfactory analysis available. Postmaster advises "parties unknown."

*Magnetic Mineral Springs, P. O.*, Terra Haute, Vigo County. This is a saline, calcic, water. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:
*Carlson's Mineral Springs, P. O.*, Laporte, Laporte County.
*Cartersburg Mineral Springs, P. O.*, Cartersburg, Hendricks County.
*Greenwood Springs, P. O.*, Fort Wayne, Allen County.
*Holman Mineral Well, P. O.*, Crawfordsville, Montgomery County.
*Mount Jackson Mineral Well, P. O.*, Indianapolis, Merion County.

## IOWA.

Iowa extends from 40°25′ to 43°30′ north latitude, and from 90°18′ to 96°53′ west longitude, and comprises an area of 56,025 square miles. In shape it is nearly that of a rectangle, measuring 310 miles from east to west, and 205 miles from north to south. The state lies within the great central prairie belt. Its surface is a plateau, with an average height of about 1000 feet above sea level, sloping gently toward the southeast, where the elevation is about 400 feet. The climate is salubrious, and is not marked by unhealthy extremes, the mean annual temperature as observed at Des Moines being 9° C. (48.94° F.), the average summer temperature being 22.2° C. (71.8° F.) and the winter, 4.8° C. (25.39° F.).

Iowa has 32 spring localities, with a total of 68 individual springs, 14 of which have been analyzed and 7 at various times used as resorts. The underlying surface of the state consists largely of Paleozoic rocks appearing in parallel belts running northeast to southwest; there is also Potsdam sandstone and carboniferous stone formations, and metamorphosed rock of the Algonkoin period, known as Sioux quartzite, the oldest formation in the state. The mineral springs in the state are not numerous; neither Walton nor Moorman mention any spring locality and Crook mentions only 7. The present list is accounted for largely by Peale. The list given herewith is taken from published sources and largely from correspondence and personal inquiry. I am indebted to W. H. Norton, State Geologist, for much valuable information.

### Colfax Mineral Springs.

(*Jasper County.*)

*Postoffice*, Colfax. *Location*, south of central Iowa; east of Des Moines, the capital city, 24 miles; southwest of Marshalltown, 35 miles; south of Webster City, 50 miles. *Situation*, in a quiet park in the town of Colfax surrounded by a rolling agricultural region. *Access*, via the Rock Island Railways System and the Des Moines & Colfax Interurban. *Hotel*, the affiliation of the Grand Hotel with the Colfax Sanitarium gives the hotel every facility for sanitarium treatment without the appearance of hospitalization. The bathing department is modern in construction and equipment, with departments for both

sexes, competent masseurs and masseuses in attendance. Every form of bath known to the science of balneotherapy is given under competent supervision, Turkish, steam cabinet, electric cabinet, salt glow and vibratory massage and Swedish movements, etc. Physicians of the surrounding territory recommend these forms of baths in chronic rheumatism and old joint disturbances, etc. The analysis below shows the mineralization:

COLFAX MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (analyst unknown). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Lithium chloride (LiCl) | trace |
| Sodium chloride (NaCl) | 65.83 |
| Potassium sulphate ($K_2SO_4$) | 7.01 |
| Sodium sulphate ($Na_2SO_4$) | 1348.50 |
| Magnesium sulphate ($MgSO_4$) | 544.97 |
| Calcium sulphate ($CaSO_4$) | 233.49 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 484.27 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 18.59 |
| Aluminum oxide ($Al_2O_3$) | 1.56 |
| Silica ($SiO_2$) | 3.42 |
| Total solids | 1707.64 |
| Gases: | |
| Carbon dioxide (free) cc. per liter | 122.70 |

Medicinal classification, weak alkaline b, sulphated or (−Ab, S), carbon-dioxated. The analysis shows this to be a moderately highly mineralized, sodic, magnesic, calcic sulphated and bicarbonated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, slight laxative and tonic properties. The "drinking cure" is beneficial in the treatment of rheumatism, stomach, bowel and kidney disorders, etc.

## Iowa Acid Spring.

*(Wapello County.)*

*Postoffice*, Eddyville. *Location*, southeast of central Iowa; southeast of Des Moines, the capital city, 60 miles; southwest of Rock Island, Ill., 125 miles. *Situation*, in the valley of the Des Moines River, at an elevation of about 650 feet above sea level. *Access*, via the Chicago Rock Island & Pacific Railway. *Hotel*, no definite information available as to class of hotel accommodation. The spring on analysis shows the following mineralization, and is of special interest, owing to the high content of free sulphuric acid.

Medicinal classification, strong acid, aluminic sulphate, ferruginous (+AcAlS, Fe). The analysis shows this to be a moderately highly mineralized, ferrous, aluminic, sulphated acid water, possessing astringent and purgative properties. This spring is remarkable in the amount of free acid which it contains, possibly being more than any

other spring in this country. Waters containing this acid are exceedingly rare. It is said that such waters are unknown in Europe.

IOWA ACID SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. H. Seiber). |
|---|---|
| Magnesium chloride ($MgCl_2$) | 14.02 |
| Sodium sulphate ($Na_2SO_4$) | 6.32 |
| Magnesium sulphate ($MgSO_4$) | 240.00 |
| Calcium sulphate ($CaSO_4$) | 761.51 |
| Ferrous sulphate ($Fe_2SO_4$) | 1,663.83 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 8,138.00 |
| Aluminum oxide ($Al_2O_3$) | 1,442.61 |
| Ammonium crenate ($NH_4$) | 138.51 |
| Sodium silicate ($Na_2SiO_3$) | 271.71 |
| Total solids | 12,678.51 |
| Sulphuric acid (free) ($H_2SO_4$) | 6,993.72 |

## Lineville Mineral Springs.

*(Wayne County.)*

*Postoffice*, Lineville. *Location*, on the midsouthern border of the state; south of Des Moines, the capital city, 75 miles; west of Burlington, 130 miles. *Situation*, among the hills bordering the Grand River and in the valley of same, at an elevation of about 1000 feet above sea level. *Access*, via the Chicago, Rock Island & Pacific Railway to Lineville, thence by motor $2\frac{1}{2}$ miles southwest to the springs. *Hotel*, there is a large commodious structure, with modern conveniences. The water is brought into the hotel by means of pipes from the spring, which extend 150 feet below the surface. The water is clear and sparkling. The analysis below shows the mineralization:

LINEVILLE MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, A. E. Woodward). |
|---|---|
| Potassium chloride (KCl) | trace |
| Sodium chloride (NaCl) | 357.69 |
| Potassium sulphate ($K_2SO_4$) | 29.75 |
| Sodium sulphate ($Na_2SO_4$) | 3283.13 |
| Magnesium sulphate ($MgSO_4$) | 54.37 |
| Calcium sulphate ($CaSO_4$) | 32.49 |
| Aluminum oxide ($Al_2O_3$) | 4.78 |
| Silica ($SiO_2$) | 1.88 |
| Total solids | 3764.09 |

Medicinal classification, sulphated 2 or (S2). The analysis shows this to be a moderately highly mineralized, sodic, sulphated and muriated saline water, sulphuretted, possessing diuretic and purgative properties. This water has been used with success in dropsical conditions due to renal disease. It has also given excellent results in

chronic constipation and functional disturbances of the liver. The sulphate ions stimulate the hepatic function, intestinal activity and liquefies intestinal secretions.

## Manawa Mineral Springs.

(*Buena Vista County.*)

*Postoffice*, Storm Lake. *Location*, in the northwestern section of the state; east of Sioux City, 60 miles; west of Fort Dodge, 65 miles. *Situation*, on the edge of this beautiful, smooth, placid lake. The surrounding country is smooth, level savannas and not particularly interesting, except for the groves and modern farm buildings. The spring area is situated in a wooded park, about 900 feet above sea level. The winter temperature ranges around zero but the summer climate is salubrious. *Access*, via Storm Lake, on the Illinois Central, Chicago & Milwaukee, St. Paul Railway and the Milwaukee & St. Louis Railways, thence by motor 1½ miles to the springs. *Hotel*, no accommodations at present. Plans are under way for the construction of a modern up-to-date sanitarium on the springs property. This new institution will be modern in construction and equipment, as well as its appointments and conveniences. The waters from these springs have been in constant use locally for more than a half century. The analyses show the mineralization:

MANAWA MINERAL SPRINGS.

| | Parts per 1,000,000 (Analyst, R. H. Carr). | |
|---|---|---|
| Hypothetical combinations. | Spring No. 1. | Spring No. 2. |
| Sodium chloride (NaCl) | trace | trace |
| Potassium sulphate ($K_2SO_4$) | 85.84 | 59.91 |
| Sodium sulphate ($Na_2SO_4$) | 102.94 | 119.87 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 3.50 | 5.18 |
| Magnesium sulphate ($MgSO_4$) | 51.36 | 47.57 |
| Calcium sulphate ($CaSO_4$) | 1017.59 | 707.30 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 295.69 | 268.86 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.85 | 9.04 |
| Silica ($SiO_2$) | 33.55 | trace |
| Total solids | 1693.32 | 1217.73 |
| Gases: | | |
| Carbonic acid (free), large amount. | | |
| Rate of flow in gallons in twenty-four hours | 86,400 | 46,080 |

Spring No. 1, medicinal classification, weak calcic sulphate 3 or (−CaS3), carbon-dioxated.

Spring No. 2, medicinal classification, weak calcic sulphate 2 or (−CaS2), carbon-dioxated.

Both of these springs are moderately highly mineralized, calcic and sodic sulphated saline waters, carbon-dioxated, possessing slight laxative and eliminative properties. The waters are said to be very effi-

cacious in the treatment of catarrhal conditions of the stomach and bowels, and are said to stimulate the secretions of the liver and gall ducts. They have been used with success in constipation and in the treatment of disorders of the bladder and kidneys. The waters are bottled and sold locally in Storm Lake and vicinity.

### Siloam Springs.

*(Hardin County.)*

*Postoffice,* Iowa Falls. *Location,* north of central Iowa; north of Des Moines, the capital city, 70 miles; west of Cedar Falls, 45 miles. *Situation,* on a small branch of the Iowa River, at an elevation of about 800 feet above sea level. *Access,* via the Chicago & Northwestern Railway, the Illinois Central Railway and the Burlington, Cedar Rapids & Northern Railway, thence by motor 1½ miles to the springs. *Hotel,* the hotel and sanitarium is a commodious structure, offering fair conveniences for comfort and enjoyment of guests. The springs issue from fault in the limestone deep below the surface, and have the following mineralization, as revealed by analysis:

SILOAM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. Bode). |
|---|---|
| Sodium chloride ($NaCl$) | 1.19 |
| Sodium sulphate ($Na_2SO_4$) | 7.35 |
| Sodium bicarbonate ($NaHCO_3$) | 69.25 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 283.01 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 663.68 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.93 |
| Ferrous oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.05 |
| Silica ($SiO_2$) | 14.14 |
| Total solids | 1042.60 |

Medicinal classification, weak alkaline b3 or (−Ab3). This is a moderately mineralized, calcic, magnesic, sodic, bicarbonated alkaline water, possessing diuretic, antacid and slight tonic properties. The analysis shows a strong resemblance to the Bethesda Spring at Waukesha, Wis. This water has been found useful as an adjunct in the treatment of neurasthenic states and gastric disturbances due to acidity. The sanitarium has a very complete bathing establishment, where the latest knowledge of balneotherapy is applied under the direction of a competent physician.

The following springs were used as resorts:

*Big Mineral Springs and Flowing Wells, P. O.,* Webster City, Hamilton County. This area has 4 flowing, artesian wells, located in Rosenkranz Park. It once maintained a large hotel, and was prominent as a resort, but no definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*White Sulphur Springs, P. O.*, White Sulphur, Scott County. This was a prominent resort many years ago, but the hotel was destroyed by fire, and we are unable to secure definite information or satisfactory analysis. Postmaster returns correspondence marked "unknown."

The following springs reported the sale of water in 1924:

*Fry's Well, P. O.*, Colfax, Jasper County.

*Grand Hotel Mineral Spring, P. O.*, Colfax, Jasper County.

*Hygeia Well, P. O.*, Sioux City, Woodbury County.

*Lime Rock Springs, P. O.*, Dubuque, Dubuque County.

## KANSAS.

Kansas extends from 94°37′ to 102° west longitude and between the parallels of 37° and 40° north latitude, and comprises an area of 82,080 square miles. The dimensions of the state are 408 miles from east to west and 208 miles from north to south; it is the central state of the union, being equidistant from the Atlantic to the Pacific, and midway between Mexico and Canada. The surface is gently undulating, with a gentle slope toward the east. The highest elevation is 3800 feet on the western border, while the mouth of the Kansas River is only 700 feet above sea level. The climate is mild and healthful, the mean annual temperature, as observed at Lawrence, being about 12° C. (53° F.), that of the summer being 24° C. (75.82° F.) and of the winter 1° C. (31.65° F.). During the summer the days are often very oppressively hot, but the nights are invariably cool.

Kansas has 31 spring localities, with a total of 129 individual springs, 24 of which have been analyzed. The mineral springs of this state have not hitherto attracted much attention; Walton does not mention any and Crook mentions only 7 in his work; Peale furnishes the information as to the number just mentioned above. There are several springs in the state which have considerable local reputation but are not known generally. The present list is taken from published works, authenticated by personal investigation and correspondence with spring owners, and fairly represents the number of active springs in the state at the present time. An examination of the list will show that the waters are mainly alkaline-saline or alkaline-saline sulphuretted. The author desires to express appreciation for information received from Dr. E. H. S. Bailey, former State Geologist, and Vol. VII, State Geological Survey.

### The Abilena Wells.

(*Dickinson County.*)

*Postoffice*, Abilene. *Location*, almost in the exact geographical center of the United States; northwest of the city of Abilene, 14 miles; west of Topeka, the capital city, 100 miles. *Situation*, in the hilly

portion of the central section of the state, where Nature failed to provide springs or living streams; therefore it was necessary in 1898 to attempt to secure water for domestic purposes and a well was driven, and when 100 feet below the earth's crust a stratum of solid rock was pierced, and this valuable cathartic water was found. *Access*, via Union Pacific, Rock Island and the Santa Fe railroads, thence 3 miles to the wells. *Hotels*, no accommodations for guests. There are now about 50 wells with an unknown capacity. The analysis below shows the mineralization:

ABILENA WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. H S. Bailey). |
|---|---|
| Sodium chloride ($NaCl$) | 588.3 |
| Sodium sulphate ($Na_2SO_4$) | 68,646.3 |
| Potassium sulphate ($K_2SO_4$) | 1,797.0 |
| Potassium nitrate ($KNO_3$) | 6.4 |
| Magnesium sulphate ($MgSO_4$) | 1,498.5 |
| Calcium sulphate ($CaSO_4$) | 817.8 |
| Sodium bicarbonate ($NaHCO_3$) | 345.8 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1,047.9 |
| Ferric bicarbonate ($Fe[HCO_3]_2$) | 10.0 |
| Silica ($SiO_2$) | 51.0 |
| Total solids | 74,883.7 |

Medicinal classification, very strong sulphate 1.5 or (++S 1.5). This is a very highly mineralized, sodic potassic sulphated saline water, possessing according to dosage, laxative, cathartic and purgative properties. It is claimed that this water contains more cathartic salts in perfect solution than is found in any other known mineral water. It acts without irritation, and has no lingering bitter taste found in many such waters; it produces liquid stools without griping or straining, and is an efficient eliminant. It may never be known whether the primary elements, which compose the base of this water were combined hypothetically during the period when the earth's crust was being formed, or whether Nature is constantly evolving definite chemical changes in her own laboratory far below the earth's surface, whereby combinations are made from the pure and simple primary elements.

## Arrington Mineral Springs.

(*Atchison County.*)

*Postoffice*, Arrington. *Location*, in northeastern Kansas and in the southwestern corner of the county; north of Topeka, the capital city, 35 miles; northwest of Kansas City, 60 miles. *Situation*, in the beautiful valley of the Delaware River, and near the banks of this stream, at an elevation of about 1000 feet above sea level. On the left bank of the river is a beautiful wooded park, where the springs flow from a fault in the underlying igneous rocks. The surroundings are pleasing; the climatic conditions are mild and equable, the air

bracing and invigorating and the scenic view restful and soothing. *Access*, via the Leavenworth & Kansas & Western Railway to Arrington Station, thence only a short distance by motor to the springs. *Hotel*, as early as 1881 improvements were begun for entertainment of guests; a modern hotel was constructed, which was later destroyed by fire, and in 1912 another resort hostelry was erected on the old site, and fitted with modern conveniences and appointments. There are a number of springs on both sides of the river, but the ones with the strongest flow are on the left bank of the river, of which we give the analyses of the more important springs, showing the mineralization:

ARRINGTON MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Kansas Geological Survey). Spring No. 1. | Spring No. 2. | Spring No. 3. |
|---|---|---|---|
| Ammonium chloride ($NH_4Cl$) | 15.2 | trace | |
| Sodium chloride ($NaCl$) | 62.2 | 37.0 | 34.4 |
| Magnesium chloride ($MgCl_2$) | ... | ... | 19.0 |
| Potassium iodide ($KI$) | ... | ... | trace |
| Sodium sulphate ($Na_2SO_4$) | 35.1 | | |
| Magnesium sulphate ($MgSO_4$) | 32.1 | ... | 220.5 |
| Calcium sulphate ($CaSO_4$) | 22.1 | ... | 5.2 |
| Potassium bicarbonate ($KHCO_3$) | 35.5 | | |
| Sodium bicarbonate ($NaHCO_3$) | 310.7 | 96.5 | |
| Lithium bicarbonate ($LiHCO_3$) | 14.8 | ... | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 176.6 | 95.3 | 61.1 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 281.0 | 183.4 | 91.4 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 93.9 | 52.8 | 120.6 |
| Silica ($SiO_2$) | 16.9 | 9.5 | 9.2 |
| Total solids | 1096.1 | 490.6 | 561.4 |

Spring No. 1, medicinal classification, weak alkaline ab2, very weak ferruginous or (−Aab2,− −Fe). This is a moderately mineralized, sodic, magnesic calcic bicarbonated alkaline (ferruginous) water, possessing diuretic, antacid, solvent and tonic properties.

Spring No. 2, medicinal classification, very weak ferruginous 0.5 or (− −Fe 0.5). This is a moderately mineralized, sodic, magnesic, ferruginous, bicarbonated alkaline water, possessing similar therapeutic properties to Spring No. 1.

Spring No. 3, medicinal classification, very weak ferruginous 1.5 or (− −Fe 1.5). This is a moderately mineralized, magnesic, sulphated ferruginous bicarbonated, alkaline-saline water, possessing laxative and tonic properties, and should be a very valuable tonic water. The sulphate radicle is present in sufficient quantity to stimulate bowel action, and the iron bicarbonate is liberal, 120 mg. to the liter; this in 2-liter doses daily would be a valuable tonic in anemia and chlorosis.

It is said that these waters are highly esteemed by the profession in the treatment of digestive disorders, general debility, rheumatism, hemorrhoids, constipation, liver and kidney disorders.

## Baxter Springs.

(*Cherokee County.*)

*Postoffice*, Baxter Springs. *Location*, in the extreme southeastern corner of the state; south of Topeka, the capital city, 155 miles; east of Winfield, 150 miles; west of Joplin, Mo., 18 miles. *Situation*, 6 miles from the Missouri boundary line and 1½ miles from the Oklahoma boundary line. *Access*, via the St. Louis & San Francisco Railway, which passes through Baxter Springs. The passenger service is good. *Hotel*, there is a typically western resort hotel here, and there are modern hotels in the town. There is a bath-house, where both hot and cold baths in many varieties are administered. There are some 30 springs in this area; at one point within a few rods square there are as many as 10 excellent springs. The locality is of great geological interest, as it is just within the area where the Mississippian formation extends from Missouri across the southeastern section of the state. The region is well watered by an abundance of springs, and is drained by Spring River, that flows for about 18 miles in the state and then passes into the state of Oklahoma to the south. Springs No. 1 and 2 are situated about 100 feet apart and covered with concrete pavilions. The city water supply comes from Spring No. 1, which flows about 12,000 gallons per day. The waters from Spring No. 2 are bottled and shipped extensively. The other waters are used medicinally and the following analyses show the mineralization:

BAXTER SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, K. B. Knerr). Spring No. 2. | Spring No. 3. | Spring No. 4. |
|---|---|---|---|
| Potassium chloride (KCl) | 8.0 | 11.6 | |
| Sodium chloride (NaCl) | 20.3 | 7.6 | 17.6 |
| Calcium chloride ($CaCl_2$) | ... | ... | 18.0 |
| Sodium sulphate ($Na_2SO_4$) | 12.2 | 14.7 | |
| Calcium sulphate ($CaSO_4$) | 158.4 | 142.2 | 158.7 |
| Magnesium sulphate ($MgSO_4$) | 27.0 | 30.2 | 2.4 |
| Potassium nitrite ($KNO_2$) | ... | 0.6 | trace |
| Potassium nitrate ($KNO_3$) | ... | ... | 6.8 |
| Calcium nitrate ($Ca[NO_3]_2$) | ... | ... | 6.2 |
| Lithium bicarbonate ($LiHCO_3$) | trace | 1.5 | 8.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 321.4 | 283.2 | 284.7 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 11.5 | 8.4 | 5.3 |
| Silica ($SiO_2$) | 13.2 | 13.2 | 15.2 |
| Total solids | 572.0 | 513.2 | 519.9 |
| Temperature, °C. | 17 | 19 | 17 |
| Flow in gallons per day | 12000 | 3500 | 2800 |

Springs No. 2, 3 and 4, medicinal classification, weak total mineralization or (−T). The amount of total solids and the percentage of the predominating chemical constituents are so close in comparison

that we may classify all these waters under one heading. The analyses show a moderately mineralized, calcic, bicarbonated and sulphated alkaline water, possessing diuretic, antacid and slight tonic properties. The waters have some reputation in the treatment of gastric disorders, due to acidity and hyperacidity. The sulphate radicles are present in solution in sufficient amount to stimulate slight bowel action and aid in the treatment of constipation. The nitrates exert diuretic action, and the ingestion of this water should be soothing to irritation of the renal and vesical organs. The water from Spring No. 2 has been bottled and shipped quite extensively.

## Blaising Natural Mineral Springs.

(*Riley County.*)

*Postoffice*, Manhattan. *Location*, northeast of central Kansas; west of Topeka, the capital city, 50 miles; south of Lincoln, Neb., 115 miles; northeast of Abilene, 45 miles; west of Kansas City, 118 miles. *Situation*, in the beautiful valley of the Kansas River, lying at an elevation of about 800 feet above sea level. *Access*, via the Chicago, Rock Island & Pacific Railway to Zeandale, thence by motor 10 miles to the springs, or via the Chicago, Rock Island and Pacific and the Northern Pacific Railways to Manhattan, thence by motor 12 miles to the springs. *Hotel*, the hotel is a comfortable resort hostelry, sitting amid a beautifully landscaped park, lying at the intersection of two creeks, occupying the side of a hill and overlooking the valley. There is a bathing establishment for administering natural mineral water baths. The springs (2 wells) are situated at the forks of the creek, bordered with a belt of timber in the shape of a horse-shoe, in the midst of which a hill arises, at its foot Well No. 1 is located and on its north side Well No. 2 is located and some 10 feet above the bottom land. The analyses below shows the mineralization:

BLAISING NATURAL MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. H. Failyer). Spring No. 1. | Spring No. 2. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | trace | trace |
| Sodium chloride (NaCl) | 26.00 | 37.00 |
| Magnesium chloride ($MgCl_2$) | 13.00 | 10.00 |
| Magnesium sulphate ($MgSO_4$) | 272.00 | 322.00 |
| Calcium sulphate ($CaSO_4$) | 1465.00 | 592.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 184.68 | 319.14 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 10.00 | 5.00 |
| Silica ($SiO_2$) | 172.00 | 180.00 |
| Total solids | 2142.68 | 1465.14 |
| Flow in gallons per day | 12,000 | 12,000 |

Spring No. 1, medicinal classification, weak calcic sulphated 4 or (−CaS4). This is a moderately highly mineralized, calcic, sulphated, saline water, possessing laxative and tonic properties.

Spring No. 2, medicinal classification, weak calcic sulphated 2 or (−CaS2). This is a moderately mineralized, calcic sulphated and bicarbonate alkaline-saline water, possessing diuretic, antacid and slight laxative properties.

These waters have been used successfully in the treatment of stomach and bowel disorders, especially where the latter are sluggish and inclined to stasis. The sulphate ions are in solution in sufficient quantities to stimulate increased flow of mucus and also to stimulate hepatic function. The waters bear shipment well and preparations are now being made to exploit the waters commercially.

## Bonner's Springs.

*(Wyandotte County.)*

*Postoffice,* Bonner's Springs. *Location,* in northeastern Kansas; south of Fort Leavenworth, 20 miles; west of Kansas City, 17 miles; east of Topeka, the capital city, 40 miles. *Situation,* at the northern end of a beautiful stretch of the Kaw River and in the valley of this river is situated the Bonner Springs, at an elevation of about 800 feet above sea level. *Access,* via the Union Pacific Railway and the Atchison & Topeka & Santa Fe Railway. The combined roads furnish splendid schedules. *Hotel,* the hotel and sanitarium combined furnish ample accommodations. The bathing "lodge" has ample accommodations for bathing and all branches of balneotherapy. The sanitarium is well conducted and offers special opportunities for nervous cases and postoperative cases. There are some 20 springs in this area, of which we present analyses of 3 of the more important ones.

BONNER'S SPRINGS.

| Hypothetical combinations. | Parts per 1,00,000 (Analyst, W. Jones, M.D.). | | | | |
|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 5. |
| Sodium chloride ($NaCl$) | ... | ... | 210.0 | | |
| Calcium chloride ($CaCl_2$) | 12.9 | 17.9 | trace | trace | trace |
| Calcium sulphate ($CaSO_4$) | 44.7 | ... | trace | | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 1749.3 | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 163.0 | trace | 223.0 | 54.35 | 64.72 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 321.6 | 372.9 | 195.2 | 46.57 | 371.20 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 36.1 | 3.7 | ... | 182.77 | 137.11 |
| Phosphoric acid ($H_3PO_4$) | trace | trace | trace | trace | trace |
| Silica ($SiO_2$) | 8.5 | 6.5 | | | |
| Total solids | 577.8 | 401.0 | 2378.0 | 282.69 | 473.03 |
| Gases: | | | | | |
| Carbon dioxide, cc. per liter | 88.8 | 59.2 | 75 | 69.5 | 74.2 |

Spring No. 1, medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic and magnesic bicarbonated, alkaline (ferruginous) water, carbon-dioxated, possessing diuretic, antacid and tonic properties.

Spring No. 2, medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic bicarbonated, alkaline (slightly ferruginous) water, possessing diuretic, antacid and slight tonic properties.

Spring No. 3, medicinal classification, alkaline a or (Aa). This is a moderately highly mineralized, sodic bicarbonated alkaline water, carbon-dioxated, possessing diuretic and antacid properties.

Spring No. 4, medicinal classification, very weak ferruginous 2 or (− −Fe2). This is a lightly mineralized, ferruginous bicarbonated, alkaline water, carbon-dioxated, possessing decided tonic properties.

Spring No. 5, medicinal classification, weak alkaline b, very weak ferruginous 2 or (−Ab, − −Fe2). This is a moderately mineralized, calcic, ferruginous, bicarbonated alkaline water, carbon-dioxated, possessing diuretic and tonic properties.

The waters from this valuable group of springs has been found efficacious in a wide range of diseased conditions. Springs Nos. 1 and 2 have been used successfully in bladder and kidney affections. Spring No. 3 in stomach bowel disorders, indigestion, etc. Springs Nos. 4 and 5 are valuable tonic and alterative waters, and have given success when administered in anemia, chlorosis and as a general tonic in run-down debilitated conditions.

## Geuda Springs.

(*Cowley County.*)

*Postoffice*, Geuda Springs. *Location*, in south central Kansas; southwest of Topeka, the capital city, 165 miles; south of Wichita, 45 miles; west of Parsons, 110 miles; north of Newkirk, Okla., 20 miles. *Situation*, on a small tableland, in a beautiful undulating section of country, at an elevation of 1400 feet above sea level. *Access*, via Arkansas City on the St. Louis & San Francisco Railway, thence by motor 7 miles to the springs. *Hotel*, a commodious hostelry and bathing establishment, fitted with modern conveniences, offers comfortable accommodations for guests. The springs, 7 in number, issue from the igneous rocks below, in an area not more than 25 by 32 feet. Near the springs is a lake of salt water covering an area of 30 square acres. The evaporation of the water from this lake causes the beach to be covered with pure crystallizable sodium chloride (common salt) which glistens in the sunshine like newly fallen snow. The name Ge-u-da is said to be an Indian appellation meaning "healing springs," and it is believed that this locality was a favorite camping ground with the aborigines centuries before the coming of the white man.

This picturesque body of water, an inland sea, constantly fed by salt springs, furnished excellent advantages for salt-water bathing. The bottom is hard and smooth, the beaches sandy and bathers can find any depth desired. The bathing establishment, modern in equipment and appurtenances, offers opportunity for any variety of bath desired. The salt-water lake also furnishes excellent opportunities for boating; a large boat-house has been constructed not far from the hotel.

GEUDA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Dr. E. H. S. Bailey and E. C. Franklin). | | | | | | |
|---|---|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 5. | Spring No. 6. | Spring No. 7. |
| Lithium chloride (LiCl) | trace | trace | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | | | | | | | |
| Sodium chloride (NaCl) | 17,679.3 | 18,122.2 | 13,986.5 | 11,518.6 | 6139.7 | 7,411.2 | 8,646.0 |
| Magnesium chloride ($MgCl_2$) | 283.6 | 342.4 | 171.7 | 135.4 | 144.9 | 85.0 | 165.8 |
| Sodium bromide (NaBr) | 0.4 | 0.4 | 0.4 | trace | trace | | |
| Sodium iodide (NaI) | trace | trace | trace | trace | trace | trace | |
| Potassium sulphate ($K_2SO_4$) | 36.4 | 28.9 | 32.7 | 32.7 | 14.2 | 9.3 | 8.2 |
| Magnesium sulphate ($MgSO_4$) | 438.3 | 415.7 | 489.3 | 456.9 | 428.4 | 418.9 | 392.1 |
| Calcium sulphate ($CaSO_4$) | 3,423.3 | 3,510.7 | 2,873.4 | 2,714.5 | 2501.0 | 2,524.7 | 2,746.6 |
| Sodium biborate ($Na_2B_4O_7$) | 2.9 | 2.9 | 2.9 | 1.5 | 2.2 | 2.2 | 4.3 |
| Sodium phosphate ($Na_2PO_4$) | 0.4 | 0.4 | 0.4 | 0.5 | 0.7 | 0.4 | 1.4 |
| Sodium nitrate ($NaNO_3$) | 6.6 | 7.0 | 3.1 | ... | 0.5 | 0.6 | 0.6 |
| Sodium bicarbonate ($NaHCO_3$) | 7.1 | 5.5 | 7.7 | 11.9 | 8.4 | 5.3 | 10.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 65.3 | 101.3 | 102.8 | 117.6 | 183.2 | 214.4 | 94.6 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.3 | 3.0 | 1.3 | 1.0 | 0.7 | 1.0 | 1.5 |
| Aluminum oxide ($Al_2O_3$) | 1.1 | 0.3 | ... | 15.8 | 0.2 | ... | 0.2 |
| Silica ($SiO_2$) | 10.4 | 14.8 | 14.0 | 13.6 | 13.6 | 12.6 | 13.7 |
| Organic matter | trace | trace | trace | trace | trace | trace | trace |
| Total solids | 21,956.4 | 22,545.5 | 17,686.2 | 15,020.0 | 9437.7 | 10,696.6 | 12,085.3 |
| Gases, cc. per liter: | | | | | | | |
| Carbon dioxide, free | 120 | 95 | 65 | 60.7 | 82.4 | 73.7 | 100 |

Spring No. 1, medicinal classification, strong saline 2, calcic sulphated 2 or (+Cl 2, CaS2), carbon-dioxated.

Spring No. 2, medicinal classification, saline 2, calcic sulphated 2 or (+Cl 2, CaS2).

Spring No. 3, medicinal classification, strong saline 1.4, calcic sulphated 1.6 or (+Cl 1.4, CaS 1.6).

Spring No. 4, medicinal classification, strong saline 1.2, calcic sulphated 1.5 or (+Cl 1.2, CaS 1.5).

Spring No. 5, medicinal classification, saline 3, calcic sulphated 1.5 or (Cl 3, CaS 1.5).

Spring No. 6, medicinal classification, saline 4, calcic sulphated 1.5 or (Cl 4, CaS 1.5).

Spring No. 7, medicinal classification, saline 4, calcic sulphated 1.6 or (Cl 4, CaS 1.6), carbon-dioxated.

The percentage of the predominating chemical constituents are so similar in all this group of springs that we may classify the group as one spring, therefore the analysis would show them to be a highly mineralized, calcic, sulphated and sodic muriated saline water, carbon-dioxated, sulphuretted. These waters have long been known and used

with success in diseases of the liver, gastrointestinal disorders, rheumatism and chronic joint disturbances, anemia and general debility. Some of the springs have a local reputation of considerable note in the local treatment of indolent ulcers, conjunctivitis, leucorrhoea etc.

The waters are bottled and shipped extensively, the bottling plant is modern in construction and equipment, and great care is exercised in the sanitary handling of the water.

## Lincoln County Springs.

(*Lincoln County.*)

*Postoffice*, Lincoln Center. *Location*, north of central Kansas; west of Topeka, the capital city, 140 miles; north of Wachita, 90 miles; south of Nelson, Neb., 85 miles. *Situation*, on the north bank of the Saline River in a rolling, hilly region, well wooded and covered with forests of indigenous trees. The surroundings are interesting, fertile farms, prosperous houses, etc. *Access*, St. Joseph & Grand Island and Chicago, Rock Island & Pacific Railways. *Hotel*, no accommodations. There are 3 springs; see analyses below:

LINCOLN COUNTY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. H. S. Bailey). Spring No .1. | Spring No. 2. | Spring No. 3. |
|---|---|---|---|
| Lithium chloride ($LiCl$) | 1.3 | 74.0 | 74.0 |
| Sodium chloride ($NaCl$) | 15,249.6 | 17,261.7 | 17,526.5 |
| Potassium sulphate ($K_2SO_4$) | 195.0 | 115.2 | 15.8 |
| Sodium sulphate ($Na_2SO_4$) | 2,961.1 | 2,295.3 | 3,919.4 |
| Magnesium sulphate ($MgSO_4$) | 393.0 | 1,585.4 | 600.7 |
| Calcium sulphate ($CaSO_4$) | 971.5 | 1,051.1 | 835.9 |
| Sodium tetraborate ($Na_2B_4O_7$) | 7.0 | 6.5 | 8.3 |
| Sodium nitrate ($NaNO_3$) | trace | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | 84.0 | 84.0 | 58.8 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1,949.5 | 947.7 | 1,017.1 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 72.0 | 5.1 | 7.3 |
| Aluminum oxide ($Al_2O_3$) | 0.5 | 4.7 | 3.4 |
| Silica ($SiO_2$) | 54.0 | 11.5 | 273.3 |
| Total solids | 22,038.5 | 23,444.2 | 24,339.5 |

Spring No. 1, medicinal classification, alkaline b, strong saline 1.5, sulphated 2 or ((Ab, +Cl 1.5, S2). This is a highly mineralized, sodic muriated, sulphated and magnesic bicarbonated, saline water, possessing diuretic, antacid, laxative and tonic properties.

Spring No. 2, medicinal classification, strong saline 1.7, sulphated 2 or (+Cl 1.7, S2). This is a highly mineralized, sodic, muriated and calcic, magnesic and sodic sulphated, saline water, possessing similar properties to No. 1.

Spring No. 3, medicinal classification, strong saline 1.8, sulphated 3 or (+Cl 1.8, S3). This is a highly mineralized, sodic muriated and sulphated saline water similar to Springs No. 1 and 2.

## Rockhart Mineral Springs.

(*Labette County.*)

*Postoffice*, Parsons. *Location*, in the southeast corner of the state; south of the capital city, Topeka, 80 miles; southeast of Wichita, 75 miles. *Situation*, in a beautiful rolling prairie country in southeastern Kansas. *Access*, via Parsons Station, on the Missouri, Kansas & Topeka Railway and the St. Louis and San Francisco Railways, only a few blocks from the springs. *Hotel*, no accommodations for guests, but there are good hotels in the town offering entertainment. The water from the spring, on analysis, shows the following mineralization:

ROCKHART MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. C. C. Young). |
|---|---|
| Sodium chloride (NaCl) | 174 |
| Sodium sulphate ($Na_2SO_4$) | 47 |
| Potassium sulphate ($K_2SO_4$) | 170 |
| Magnesium sulphate ($MgSO_4$) | 248 |
| Calcium sulphate ($CaSO_4$) | 78 |
| Sodium nitrate ($NaNO_3$) | 8 |
| Sodium bicarbonate ($NaHCO_3$) | 742 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 5 |
| Silica ($SiO_2$) | 6 |
| Total solids | 1278 |

Medicinal classification, weak alkaline a2, weak sulphate or (−Aa2, −S). This spring flows at the rate of 5000 gallons per day, and the analysis shows a moderately highly mineralized, sodic, bicarbonated, magnesic, sulphated, alkaline-saline water, possessing diuretic and antacid properties. The predominating chemical constituent is sodium bicarbonate, producing a water of a mild Vichy type, and should be a satisfactory table water and have some virtue in mild acid disturbances of the stomach. It is claimed that the physicians in Parsons prescribe it freely and endorse it in disorders of the stomach due to acidity. The waters have been bottled and sold for many years, and have some reputation as a medicinal water in that section of the country.

## Sycamore Springs.

(*Brown Country.*)

*Postoffice*, Springs. *Location*, in northeastern Kansas; north of Topeka, the capital city, 60 miles; west of St. Joseph, Mo., 55 miles; south of the Nebraska state line, 10 miles; west of Hiawatha, the county seat, 10 miles. *Situation*, in the valley of Sycamore Creek, which runs north into Nehama River. The altitude is about 1000 feet above tide water. *Access*, St. Joseph & Grand Island and Chicago,

Rock Island & Pacific Railways. *Hotel*, a small modern resort hostelry, with fair accommodations. The bathing department contains separate sections for men and women.

SYCAMORE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. B. Knerr). Sycamore Spring, No. 1. | Sycamore Spring, No. 2. |
|---|---|---|
| Potassium chloride (KCl) | 3.4 | 5.1 |
| Sodium chloride (NaCl) | 131.7 | 96.7 |
| Sodium sulphate ($Na_2SO_4$) | 16.8 | 34.3 |
| Magnesium sulphate ($MgSO_4$) | 287.9 | 277.3 |
| Calcium sulphate ($CaSO_4$) | 1593.4 | 1731.8 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 549.0 | 484.0 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.4 | 5.3 |
| Silica ($SiO_2$) | 22.4 | 21.2 |
| Total solids | 2609.0 | 2637.7 |
| Temperature, °C. | 12.4 | 12.5 |

Sycamore Springs, No. 1 and 2, medicinal classification, weak alkaline b, calcic sulphated or (−Ab, CaS). These are moderately highly mineralized, calcic sulphated and bicarbonated alkaline waters, possessing diuretic antacid, laxative and tonic properties.

## Sun Springs.

(*Brown County.*)

*Postoffice*, Hiawatha, R. F. D. No. 3. *Location*, in northeastern Kansas; north of Topeka, the capital city, 60 miles; west of Savannah, Mo., 45 miles; south of Nebraska City, Neb., 50 miles; west of St. Joseph, Mo., 48 miles; southwest of Morrill, the railway station, 3 miles. *Situation*, in a high rolling undulating savanna-like region, west of the Missouri River, at an elevation of about 750 feet above sea level, in the picturesque valley of Mulberry Creek, which runs east, then north and joins the Nehama River, which empties into the Missouri River. *Access*, via Morrill Station, on the St. Joseph & Grand Island Railway, thence a distance of 3 miles by motor to the springs. *Hotel*, there is a modern resort hostelry, with fair accommodations. A bathing establishment, modern in construction and equipment, has been erected, and every facility is at hand for administering a great variety of hot and cold baths. The analysis on page 386 shows the mineralization:

Spring No. 1, medicinal classification, weak alkaline b, calcic sulphate or (−Ab, CaS).

Spring No. 2, medicinal classification, weak alkaline b2, calcic sulphate or (−Ab2, CaS).

Spring No. 3, medicinal classification, weak alkaline b2, weak calcic sulphate 4 or (−Ab2, −CaS4).

Spring No. 4, medicinal classification, calcic sulphate or (CaS).

SUN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. B. Kneer.) | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Potassium chloride (KCl) | ... | ... | 6.1 | 0.7 |
| Sodium chloride (NaCl) | 70.0 | 40.8 | 77.0 | 81.3 |
| Sodium sulphate ($Na_2SO_4$) | 83.1 | 11.4 | 20.5 | 87.1 |
| Magnesium sulphate ($MgSO_4$) | ... | 1.8 | 208.4 | 37.0 |
| Calcium sulphate ($CaSO_4$) | 1916.9 | 1941.9 | 1572.0 | 1841.5 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 367.2 | | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 132.9 | 681.4 | 677.8 | 7.4 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 5.5 | 8.8 | 5.8 | 8.0 |
| Silica ($SiO_2$) | 21.1 | 18.0 | 28.8 | 20.4 |
| Total solids | 2640.0 | 2704.1 | 2596.4 | 2083.4 |
| Temperature, °C. | 16 | 14 | 16.2 | 14.7 |
| Flow in gallons per day | 120,000 | 14,400 | 10,000 | 8000 |

Spring No. 1 is situated a few rods southwest of the hotel. It has been improved and built up with cement, being 8 feet in diameter and 8 feet in depth. It is fitted with an overflow pipe 6 inches in diameter. The water boils up through sand and broken shale at the bottom and is perfectly clear at all times. It gives off a slight amount of hydrogen sulphide gas.

The amount of total solids and the percentage of the predominating chemical constituents are so similar that we may be safe in classing these 4 springs under one type, as moderately highly mineralized, calcic sulphated and bicarbonated alkaline water, possessing diuretic, antacid and slight tonic properties. These waters have been used in the treatment of stomach and bowel disorders, affections of the kidney and bladder and in congestion of the liver. They have some reputation as a tonic in run-down, debilitated conditions, where an iron tonic is indicated.

## Waconda Springs.

### (*Mitchel County.*)

*Postoffice,* Cawker City. *Location,* in the northern tier of counties, about midway between the eastern and western boundaries of the state; west of Beloit, the county seat, 16 miles; south of Hastings, Neb., about 80 miles; west of Topeka, the capital city, about 160 miles. *Situation,* atop a plateau 3500 feet above sea level, and some 40 feet higher than its environs; in the middle of this tableland the springs gush forth from the bowels of the earth. *Access,* via Missouri Pacific Railway; station only a few rods from the hotel. *Hotels,* near the spring is situated the hotel and sanitarium, of pleasing architectural

design, of faced stone construction, commodious and comfortable. There is a modern bathing establishment connected with the sanitarium, where the science of hydrotherapy and balneotheropy is applied by a corps of trained assistants, under the direct supervision of an eminent physician. The spring is 60 feet in diameter, and is surrounded by a natural rock platform from 80 to 150 feet wide and so perfect in its arrangement as to appear as if hewn out by the hand of man. The diameter of the base of this mound or plateau is 117 yards from north to south and 119 yards from east to west, while the circumference is some 60 rods. The geological formation of this spot is of great scientific interest; some geologists claim that Waconda Spring was at some remote period a boiling spring. The source of the water is from great depths, coming up through strata of saliferous shales, from 600 to 800 feet in thickness, overlying the Dakota sandstone, which volcanic disturbances many centuries ago left with fissures or faults, through which the water is forced upward. The red men knew of and appreciated the healing virtues of this water centuries before the advent of the white man. The waters show the following mineralization:

WACONDA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. H. S. Bailey). Springs No. 1. | Spring No. 2. |
|---|---|---|
| Sodium chloride ($NaCl$) | 12,823.8 | 12,208.4 |
| Potassium sulphate ($K_2SO_4$) | ... | 392.4 |
| Sodium sulphate ($Na_2SO_4$) | 3,794.9 | 2,411.2 |
| Magnesium sulphate ($MgSO_4$) | 978.6 | 1,734.9 |
| Sodium biborate ($Na_2B_4O_7$) | ... | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 585.2 | 1,118.5 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1,208.5 | 133.1 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 19.1 | |
| Aluminum oxide ($Al_2O_3$) | ... | 16.6 |
| Silica ($SiO_2$) | 17.2 | 15.3 |
| Total solids | 19,526.0 | 18,030.5 |

Spring No. 1, medicinal classification, alkaline b, strong saline, sulphate 2 or (Ab, +Cl, S2).

Spring No. 2, medicinal classification, weak alkaline b3, strong saline, sulphate 2 or (−Ab3, +Cl, S2).

Both of these waters are highly mineralized, sodic, muriated, sulphated and saline. Waconda Spring, No. 2, is located about ½ mile southeast of the Great Spirit Spring, Waconda Spring, No. 1. It is surrounded on all three sides by a bend in the river and, though water cannot be seen to come up through the rock, there is probably a rock deposit beneath the alluvium of the valley, and no doubt the water comes up through the crevices of this rock.

It will be seen, from a close scrutiny of the analysis of each spring, that the waters are much alike, and that the predominating chemical constituents are about in the same proportion. They may be classed

as highly mineralized, sodic muriated, sulphated, saline waters. As would be expected, the spring in the valley, subject to the erosion of high waters, would not show the same tendency to build up a mound, as in the case of Spring No. 1, which is now situated on high ground, and has possibly taken a thousand centuries to form the great mound. Both the waters are natural laxatives and tonics and have been used where the nervous system needed toning up. The waters are helpful in acid conditions of the stomach, catarrhal disturbances of the alimentary tract, colitis, gall-stones, malassimilation, etc. The waters are bottled, shipped and sold commercially. The sanitarium is directed by a competent medical man, with specialists in the following departments: Hydrotherapy, neurotherapy, electrotherapy, dietotherapy, chiropractic, massage, etc.

The following springs were once used as resorts:

*Louisville Mineral Springs, P. O.*, Louisville, Pottawatomie County. A quarter of a century past these springs were very popular. Two hotels and cottages, surrounded by a beautiful blue-grass park, but at present no definite information nor satisfactory analysis available. Correspondence returned marked "unknown."

*Moodyville Mineral Springs, P. O.*, Moodyville, Pottawatomie County. Hotel and cottages. No definite information nor satisfactory analysis available.

*Topeka Mineral Wells, P. O.*, Topeka, Shawnee County. Located on Harrison Street in the city of Topeka. Hotel and bathing establishment as early as 1879, but today no definite information nor satisfactory analysis available.

The following reported the sale of water during 1924:

*Conway Springs, P. O.*, Conway Springs, Butler County.
*Crystal Springs, P. O.*, Coffeeville, Montgomery County.
*Mineral Rock Springs, P. O.*, Kansas City, Wyandotte County.
*Mission Springs, P. O.*, Mission, Harvey County.
*Sunnydale Springs, P. O.*, Valley Center, Sedgwick County.
*Viola Springs, P. O.*, Viola, Sedgwick County.

## KENTUCKY.

Kentucky extends from 36°30′ to 39°.06′ north latitude, and from 82°.06′ to 89°44′ west longitude, and comprises an area of 40,400 square miles. Its greatest length is nearly 400 miles and its greatest breadth is about 180 miles. About 400 square miles of the state's area is covered with water. The only mountains in the state is the Cumberland Range, which separates Kentucky from Virginia. The eastern counties are rugged and broken by this range of mountains. The banks of the rivers are natural curiosities in some sections, having worn very deep chasms in the rocks over which they flow. The precipices formed by the Kentucky River in many places present banks 300 feet in solid limestone. The average altitude is about 800

feet. In the southeastern part the Cumberland Ridges of the Alleghany Mountains include elevations ranging from 2000 to 3000 feet above sea level. The remaining portion of eastern Kentucky is an upland, and has a surface diversified by rounded hills and deeply eroded valleys which follow the general northwesterly slope. The climate here is variable; but Kentucky is marked by no unhealthy extremes, the mean annual temperature being 13° C. (55° F.), that of the summer 23.3° C. (73.96° F.) and that of winter 3.3° C. (38° F.). There is little snow in winter and, while the thermometer may fall to −17.8° C. (0° F.), such weather is of short duration.

Kentucky has 142 spring localities, with a total of 296 individual springs, 73 of which have been analyzed and at various times 21 of them have been used as resorts. In the past Kentucky has occupied a prominent place as a mineral spring region, not only from the number of springs but also on account of the quality of the waters. Some of them are among the most remarkable in the country, and have been on sale in all parts of the country. Walton describes 11 localities which have been used as resorts, Crook mentions 7 and Peale's list includes 21 used as resorts. There is no doubt but that the Kentucky Springs are not enjoying the popularity and esteem they once possessed. The following list is made up from state and Federal geological surveys, from correspondence with spring owners and prominent physicians.

### Clear Creek Springs.

*(Bell County.)*

*Postoffice,* Pineville. *Location,* in the corner of southeastern Kentucky; north of Knoxville, Tenn., 50 miles; west of Jonesville, Va., 35 miles. *Situation,* in Clear Creek Valley, in the heart of the Cumberland Mountains, at an elevation of 2200 feet above sea level. The climate is bracing and invigorating, the surroundings charming and delightful, restful and soothing to the overworked business man or the society matron upon whom club life has made too exacting demands. *Access,* via the Louisville & Nashville Railway to Pineville, thence only a short distance by motor to the springs. *Hotel,* there are two splendid hostelries, both with modern conveniences. The analysis below shows the mineralization of the water:

CLEAR CREEK SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert Peter, Ph.D.). |
|---|---|
| Sodium chloride ($NaCl$) | trace |
| Calcium chloride ($CaCl_2$) | 1.74 |
| Magnesium sulphate ($MgSO_4$) | 24.47 |
| Calcium sulphate ($CaSO_4$) | 5.64 |
| Sodium bicarbonate ($NaHCO_3$) | 50.99 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 57.38 |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silica ($SiO_2$) | 8.72 |
| Total solids | 148.94 |

The analysis shows this to be a lightly mineralized, calcic and sodic bicarbonated, alkaline water, possessing diuretic and antacid properties. The waters are said to enjoy considerable reputation in dyspepsia, liver and kidney affections, skin diseases and disorders of the female pelvic organs. It is a remarkable pure potable water, well adapted for table purposes. It is bottled and shipped.

## Crab Orchard Springs.

(*Lincoln County.*)

*Postoffice,* Crab Orchard. Location, east of central Kentucky; south of Frankfort, the capital city, 60 miles; southeast of Louisville, 115 miles; north of Sommerset, 25 miles; south of Danville, 25 miles. *Situation,* in a broken, hilly, mountainous region of eroded valleys and forested hills, presenting interesting scenic vistas of great grandeur and natural beauty. *Access,* via the Knoxville Branch of the Louisville & Nashville Railway. *Hotel,* no definite information available. These waters are used principally in the manufacture of Crab Orchard Salts. The analysis shows the mineralization:

CRAB ORCHARD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert Peter). | |
|---|---|---|
| | Field Spring. | Grove Spring. |
| Sodium chloride (NaCl) | 10.0 | 10.0 |
| Potassium sulphate ($K_2SO_4$) | 20.0 | 10.0 |
| Sodium sulphate ($Na_2SO_4$) | 20.0 | |
| Magnesium sulphate ($MgSO_4$) | 70.0 | 60.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 130.0 | 40.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 140.0 | 190.0 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 10.0 | 10.0 |
| Silica ($SiO_2$) | 40.0 | 40.0 |
| Total solids | 440.0 | 360.0 |

Field Spring, medicinal classification, weak total mineralization or (−T).

The percentage of the predominating chemical constituents runs so close that these waters may be classed as moderately mineralized, calcic, magnesic, bicarbonated, alkaline waters, possessing diuretic and antacid properties. The waters and salts from its evaporation have a wide reputation in the treatment of constipation.

## Cerulean Springs.

(*Trigg County.*)

*Postoffice,* Cerulean. *Location,* in southwestern Kentucky; southwest of Louisville, 197 miles; southwest of Frankfort, the capital city,

225 miles; south of Evansville, Ind., 85 miles; northwest of Nashville, Tenn. *Situation*, on a terminal spur of the Cumberland Range of Mountains, at an elevation of about 850 feet above sea level. *Access*, via Cerulean Station, on the Hopkinsville Branch of the Illinois Central Railway, thence only a short distance to the springs. *Hotel*, the first hotel was opened to the public in 1819. On August 29, 1925, it was completely destroyed by fire. The owner writes that a new fireproof resort hostelry will be built in 1927 to accommodate 250 guests. The new bathing establishment will be modern in construction and equipment. The water on analysis shows the following mineralization:

CERULEAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Herman Schlundt). |
|---|---|
| Sodium chloride ($NaCl$) | trace |
| Calcium chloride ($CaCl_2$) | trace |
| Magnesium sulphate ($MgSO_4$) | 39.5 |
| Sodium bicarbonate ($NaHCO_3$) | 42.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 50.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 87.2 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 81.9 |
| Aluminum oxide ($Al_2O_3$) | 55.6 |
| Sodium silicate ($Na_2SiO_3$) | 75.4 |
| Silica ($SiO_2$) | 92.5 |
| Total solids | 524.7 |

Gases:
Hydrogen sulphide, heavily charged.

Medicinal classification, very weak ferruginous or (— —Fe), sulphuretted. This is a moderately mineralized, sodic, magnesic, calcic, ferric, bicarbonated, alkaline (aluminic) water, sulphuretted, radio-activated, possessing diuretic antacid, tonic and alterative properties. The bicarbonate of iron is present in sufficient quantities to exert beneficial tonic properties, indicated in all run-down, depleted conditions, anemia and depravity of the blood and blood-making organs. The Cerulean Springs water is highly endorsed by the local profession in disorders of the stomach, kidneys and liver. There is sufficient sulphate ions in solution to exert mild laxative action with elimination of toxic poisons from the bowels and blood. Prof. Herman Schlundt, Department of Chemistry, Columbia University, has tested the water and found it to possess marked radio-activity.

## Estill Springs.

(*Estill County.*)

*Postoffice*, Estill Springs, R. F. D. from Irvine. *Location*, in eastern Kentucky; southeast of Frankfort, the capital city, 55 miles; south-

west of Cattlesburg, W. Va., 100 miles. *Situation*, in the valley of the Kentucky River, at an altitude of about 1500 feet above sea level. *Access*, Kentucky Central Railroad and Chesapeake & Ohio and Baltimore & Ohio and connection lines. *Hotel*, there are said to be very good accommodations, but no definite information available. There are a number of springs in this area; see analysis below:

ESTILL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert Peter). | | | | |
|---|---|---|---|---|---|
| | Red Sulphur Spring No. 1. | White Sulphur Spring. | Red Sulphur Spring No. 2. | Chaly-beate Spring. | Black Sulphur Spring. |
| Sodium chloride ($NaCl$) | 90.0 | 10.0 | 100.0 | 10.0 | 40.0 |
| Calcium chloride ($CaCl_2$) | ... | ... | 110.0 | | |
| Potassium sulphate ($K_2SO_4$) | 90.0 | 70.0 | 10.0 | 10.0 | 20.0 |
| Sodium sulphate ($Na_2SO_4$) | 170.0 | 40.0 | ... | 10.0 | 30.0 |
| Calcium sulphate ($CaSO_4$) | ... | ... | ... | 280.0 | |
| Magnesium sulphate ($MgSO_4$) | 10.0 | 110.0 | 40.0 | 170.0 | 20.0 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | ... | ... | 20.0 |
| Sodium bicarbonate ($NaHCO_3$) | 324.4 | 128.0 | | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 129.0 | 16.2 | 34.4 | 81.0 | 48.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 324.0 | 32.4 | 178.0 | | |
| Silica ($SiO_2$) | 10.0 | trace | 30.0 | 110.0 | 10.0 |
| Total solids | 1147.4 | 406.6 | 502.4 | 701.0 | 168.6 |

Red Sulphur Spring, No. 1, medicinal classification, weak alkaline ab2 or (−Aab2). This is a moderately highly mineralized, sodic, calcic, magnesic, bicarbonated and sodic sulphated and muriated alkaline-saline water, sulphuretted, possessing diuretic, antacid and slight laxative properties.

White Sulphur Spring, medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, magnesic, potassic sodic sulphated and bicarbonated alkaline-saline water, sulphuretted, possessing diuretic and antacid properties.

Red Sulphur Spring, No. 2, medicinal classification, weak total mineralization or (−T). This is a moderately mineralized calcic, sodic muriated and bicarbonated alkaline-saline water, sulphuretted, possessing diuretic and antacid properties.

Chalybeate Springs, medicinal classification, weak sulphated or (−S). This is a moderately mineralized calcic and magnesic sulphated saline water, possessing diuretic and purgative properties.

Black Sulphur Springs is a lightly mineralized, sodic muriated, magnesic, potassic, aluminic sulphated saline water, sulphuretted, possessing similar properties to Red Sulphur Spring, No. 1.

## Graham Springs.

(*Pope County.*)

*Postoffice*, Harrodsburg. *Location*, near the center of the state; south of Frankfort, the capital city, 30 miles; southeast of Louisville, 85 miles; north of Danville, 10 miles. *Situation*, the springs are situated in a beautiful little valley near the source of the Salt River, in the midst of the noted blue grass region, for which the state is famous; beautiful, rolling, undulating plains. *Access*, via Harrodsburg Station on the Southern Railway, through trains from Louisville and Lexington; via the Queen & Crescent route, through trains from Cincinnati and Chattanooga; by motor over splendid national highways, through a wonderfully picturesque blue-grass country. *Hotel*, there is a commodious summer resort hostelry with modern conveniences; besides, there are a number of comfortable cottages for those who prefer seclusion and quiet. The springs, famous for a century, on analysis show the following mineralization:

GRAHAM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Raymond). | |
|---|---|---|
| | Greeneville Spring. | Saloon Spring. |
| Sodium chloride (NaCl) | trace | 21.20 |
| Calcium sulphate ($CaSO_4$) | 189.12 | 175.10 |
| Magnesium sulphate ($MgSO_4$) | 276.33 | 477.09 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 10.26 | 8.24 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 85.28 | 7.72 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | none | 9.43 |
| Silica ($SiO_2$) | | |
| Total solids | 560.99 | 698.78 |

Greenville Spring, medicinal classification, weak sulphate or (−S). This is a moderately mineralized, magnesic, calcic, sulphated saline water, possessing slight laxative properties.

Saloon Spring, medicinal classification, weak sulphate or (−S). This is a moderately mineralized, magnesic, calcic, sulphated saline (ferruginous) water, possessing diuretic and tonic properties.

Both springs are valuable waters in the treatment of diseases of the liver and catarrhal conditions of the gastro-intestinal tract, where there is sluggish bowel action. Dr. Drake says: "These waters are very beneficial in chronic inflammations and obstructions of the abdominal viscera; in such cases of dyspepsia as are attended with subacute gastritis and in almost every type of hepatic disorder."

Dr. Christopher C. Graham developed this property prior to 1820, when he built a magnificent hotel at a cost, at that time, of $300,000, which was destroyed by fire in 1865, after which the present modern hotel was constructed. Prior to the war of 1861–1865 this place was

referred to as "the Saratoga of the South;" here gathered, year after year, the elite of Kentucky and adjoining states, to drink the waters and enjoy the social life of the Graham Springs Hotel.

## Grayson Springs.

*(Grayson County.)*

*Postoffice,* Grayson Springs. *Location,* a little west of central Kentucky; southwest of Louisville, 68 miles; southwest of Frankfort, the capital city, 100 miles; north of Bowling Green, 40 miles. *Situation,* in a natural amphitheatre in a beautiful valley about 550 feet above sea level. *Access,* via Grayson Springs Depot, on the main line of the Illinois Central Railway, thence by motor, a distance of $2\frac{1}{2}$ miles, to the springs. *Hotel,* the hotel is a capacious structure of southern architecture, with modern conveniences. The springs, some 20 or more in number, issue from the bosom of Mother Nature in the confines of this beautiful park. In addition to the valuable mineral waters, for which Grayson Springs has long been famous, there is a very large mammoth spring of pure free-stone water, which furnishes the water supply for the hotel cottages, kitchen and laundry, and for guests not wishing to use the various highly mineralized medicinal waters. The analyses below show the mineralization of several of the more important waters:

GRAYSON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Robert Peter). | | | | | |
|---|---|---|---|---|---|---|
| | Center Spring. | Willow Spring. | McAtee Spring. | Stump Spring. | West Sulphur Spring. | Hymneal Spring. |
| Sodium chloride (NaCl) | 180.80 | 14.5 | | | | |
| Magnesium chloride ($MgCl_2$) | 3.40 | 2.9 | 6.0 | 2.2 | 5.8 | 3.2 |
| Potassium sulphate ($K_2SO_4$) | ... | ... | 2.4 | 2.3 | ... | 8.5 |
| Sodium sulphate ($Na_2SO_4$) | 50.21 | 40.9 | 12.6 | 37.4 | 25.9 | 22.0 |
| Magnesium sulphate ($MgSO_4$) | 575.40 | 370.8 | 561.6 | 609.3 | 652.2 | 885.5 |
| Calcium sulphate ($CaSO_4$) | 1164.90 | 454.1 | 452.8 | 629.1 | 650.5 | 900.1 |
| Manganese sulphate ($MnSO_4$) | 3.40 | 0.7 | 19.2 | trace | trace | trace |
| Sodium bromide (NaBr) | trace | trace | trace | trace | trace | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 281.43 | 316.3 | 292.6 | 324.4 | 296.8 | 247.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | trace | 82.9 | 14.9 | trace | 2.9 | trace |
| Lithium bicarbonate ($LiHCO_3$) | trace | trace | trace | trace | trace | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.70 | 4.8 | 7.8 | 6.6 | ... | 7.2 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 7.10 | 7.3 | 27.0 | 6.0 | 9.6 | |
| Silica ($SiO_2$) | 5.60 | 12.3 | 8.8 | 3.2 | 16.2 | 7.1 |
| Total solids | 2278.94 | 1309.5 | 1397.9 | 1613.9 | 1459.6 | 2073.4 |
| Gases: | | | | | | |
| Carbon dioxide, cc. per liter | 19.5 | 12.3 | 115.0 | 16.5 | | |
| Sulphuretted hydrogen, cc. per liter | 20.0 | 24.8 | 20.3 | 41.0 | 27.0 | 27.0 |
| Temperature, °C. | 15.8 | 18.9 | 15.8 | 17.8 | 16.7 | 14.4 |

Center Spring, medicinal classification, weak sulphated 4 or (−S4), sulphuretted.

Willow Spring, medicinal classification, weak sulphated 2 or (−S2), sulphuretted.

McAtee Spring, medicinal classification, weak sulphated 3 or (−S3), carbon-dioxated, sulphuretted.

A careful study of the above analyses shows these 3 springs to be moderately highly mineralized, calcic, magnesic, sulphated saline (manganic) waters, sulphuretted, possessing diuretic, tonic and alterative properties.

Stump Spring and West Sulphur Spring, medicinal classification, weak sulphated 3 or (−S3), sulphuretted.

Hymneal Spring, medicinal classification, sulphated or (S), sulphuretted.

These 3 springs are moderately highly mineralized, calcic, magnesic, sulphated, saline waters, sulphuretted, possessing diuretic and tonic properties.

The waters from these springs have the endorsement of the profession, who have long used them with success in the treatment of a wide range of diseased conditions, catarrhal disorders of the intestinal tract, hepatic disturbances, irritations of the genito-urinary tract, rheumatism and chronic joint disturbances. The iron content of the various waters make them admirable tonics, indicated in all depraved conditions of the blood and blood-making organs, anemia, chlorosis, leucocythemia, etc. The manganese content of the Center, Willow and McAtee Springs gives them additional alterative tonic properties. The last-named springs are especially valuable in the treatment of menstrual irregularities of women and young girls. Children in ill health, who need a change, do well when put on these waters. The overworked business man and the society matron, whose nerves are shattered from the demands of club life, will find this old resort a delightful place to recuperate and get a new hold on life.

### Hamby's Genuine Dawson Springs.

(*Hopkins County.*)

*Postoffice,* Dawson Springs. *Location,* in the western part of the state; east of Paducah, 50 miles; south of Evansville, Ind., 60 miles; northeast of Bowling Green, 80 miles; southwest of Louisville, 166 miles. *Situation,* in the midst of a fertile valley, through which runs the Trade Water River on its rush to join the Ohio River. The springs are on a slight rise of tableland, 800 feet above sea level. *Access,* via the main line of the Illinois Central Railway, thence a short distance of 200 yards to the springs. *Hotel,* this is an all-year-round resort town, with some 20 hotels. The capacity of the combined hotels is about 1500 guests. There are 3 modern bathing establishments, fully equipped with every appurtenance for the scientific practice of hydrotherapy and balneotherapy. The analysis of Hamby's Genuine Dawson Springs shows the following mineralization:

HAMBY'S GENUINE DAWSON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, A. C. Lyons). |
|---|---|
| Sodium chloride ($NaCl$) | 155.514 |
| Potassium sulphate ($K_2SO_4$) | 113.757 |
| Sodium sulphate ($Na_2SO_4$) | 704.178 |
| Magnesium sulphate ($MgSO_4$) | 866.336 |
| Calcium sulphate ($CaSO_4$) | 964.922 |
| Sodium bromide ($NaBr$) | trace |
| Calcium nitrate ($CaNO_3$) | 5.157 |
| Sodium phosphate ($Na_3PO_4$) | 15.273 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 195.482 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 742.362 |
| Lithium bicarbonate ($LiHCO_3$) | trace |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 49.475 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 87.774 |
| Aluminum oxide ($Al_2O_3$) | 3.173 |
| Silica ($SiO_2$) | 28.167 |
| Total solids | 3971.370 |

Medicinal classification, weak alkaline b3, sulphate or (−Ab3, S). This is a moderately highly mineralized, calcic, magnesic and potassic sodic, sulphated, alkaline-saline (ferruginous, manganic) water, with an inexhaustible flow. The therapeutic properties of this water is due to the sulphates of calcium, magnesium and sodium blended in nearly equal proportions, giving the water a pleasing laxative action, without the excessive bitter taste usually present after drinking waters of this class. The waters are highly endorsed by the medical profession for the relief of constipation and in catarrhal conditions of the alimentary tract and in diseases of the liver and gall-bladder. In addition to the therapeutic properties of the water above noted, it contains among its chemical constituents, valuable tonic and alterative constituents, manganese and iron—both as bicarbonates which is the most valuable form in which these elements can be prescribed; in this form they are readily assimilated and absorbed by the system. They are indicated wherever there is a depraved condition of the blood and blood-making organs, viz. anemia, chlorosis and leucocythemia and general malnutrition.

## Kentucky Carlsbad Springs.

(*Grant County.*)

*Postoffice*, Dry Ridge. *Location*, in the northern portion of the state; north of Frankfort, the capital city, 30 miles; northeast of Louisville, 75 miles. *Situation*, in a rolling, undulating valley, lying between the Kentucky River on the southeast and the Licking River on the northeast, at an elevation of 1000 feet above sea level. *Access*, via the Cincinnati Southern Railway to Dry Ridge Station, thence only a short distance to the springs. *Hotel*, there is a commodious and comfortable resort hostelry open throughout the year. The hotel

maintains a sanatorium in connection with the hotel, where patients receive all the attention of a regular hospital. The analysis shows the following mineralization:

KENTUCKY CARLSBAD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. Simonson). |
|---|---|
| Sodium chloride ($NaCl$) | 3133.23 |
| Sodium bromide ($NaBr$) | 1.20 |
| Potassium sulphate ($K_2SO_4$) | 100.55 |
| Sodium sulphate ($Na_2SO_4$) | 240.60 |
| Sodium hydrosulphide ($Na_2S_2O_3$) | 88.40 |
| Sodium bicarbonate ($NaHCO_3$) | 73.53 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 180.99 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 288.10 |
| Lithium bicarbonate ($LiHCO_3$) | 9.44 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 15.68 |
| Ferrous sulphide ($FeS$) | 12.48 |
| Total solids | 4144.20 |

Medicinal classification, weak alkaline b, saline 1.5, weak sulphate or (−Ab, Cl 1.5, −S). A careful examination of the analysis shows a moderately highly mineralized, sodic, muriated, saline water, possessing aperient, diuretic, tonic and alterative properties. Highly endorsed by the local profession in the treatment of rheumatism, catarrhal conditions of the intestinal tract, kidney and liver troubles. The company operating the springs and hotel maintain a modern up-to-date bottling plant, and for many years have bottled and shipped the water extensively throughout Kentucky and adjoining states.

## Lower Blue Lick Springs.

(*Nicholas County.*)

*Postoffice,* Carlisle. *Location,* in northeastern Kentucky; south of Covington, 60 miles; north of Mt. Sterling, 20 miles; west of Cattlesburg, W. Va., 80 miles; east of Louisville, 100 miles; northeast of Lexington, 35 miles. *Situation,* in the valley of the Licking River, 1800 feet above sea level, in the famous "blue-grass" section of the state, surrounded by high hills deeply forested. *Access,* via the Chesapeake & Ohio Railway and connections. *Hotel,* no available information as to class of accommodations. The analysis on next page shows the mineralization:

Medicinal classification, strong saline or (+Cl), carbon-dioxated, sulphuretted. The analysis shows this to be a highly mineralized, sodic, muriated and calcic, sulphated and bicarbonated saline (bromic, strontic) water, sulphuretted and carbon-dioxated, possessing diuretic, laxative and alterative properties. This is a very valuable water in the treatment of engorgements of the liver and abdominal, visceral, gastric, catarrhal and kindred affections.

LOWER BLUE LICK SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert Peter). |
|---|---|
| Potassium chloride (KCl) | 186.0 |
| Sodium chloride (NaCl) | 8,357.1 |
| Lithium chloride (LiCl) | 6.0 |
| Magnesium chloride ($MgCl_2$) | 486.4 |
| Calcium chloride ($CaCl_2$) | 60.6 |
| Magnesium bromide ($MgBr_2$) | 19.5 |
| Magnesium iodide ($MgI_2$) | 0.3 |
| Calcium sulphate ($CaSO_4$) | 550.8 |
| Strontium sulphate ($SrSO_4$) | 1.1 |
| Barium sulphate ($BaSO_4$) | 0.2 |
| Sodium biborate ($Na_2B_4O_7$) | 29.8 |
| Sodium bicarbonate ($NaHCO_3$) | 22.7 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 34.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 515.8 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 6.2 |
| Silica ($SiO_2$) | 14.9 |
| Sodium sulphite ($Na_2SO_3 + 7H_2O$) | 30.7 |
| Total solids | 10,322.3 |
| Gases: | |
| Sulphuretted hydrogen | 394.7 |
| Carbon dioxide | 357.4 |

## Olympia Springs.

(*Bath County.*)

*Postoffice*, Olympia. *Location*, in eastern Kentucky; east of Frankfort, the capital city, 60 miles; south of Cincinnati, O., 75 miles. *Situation*, in the western spurs of the Blue Ridge Mountains, at an elevation of about 2000 feet above tide water, surrounded by a rough, rugged, mountainous region. *Access*, via the Chesapeake & Ohio Railway. *Hotel*, no information available as to the character of accommodations. There are quite a number of springs in this area. The analyses on page 399 show the mineralization:

Salt Sulphur Spring, medicinal classification, weak alkaline b2, saline 2.5 or (−Ab2, Cl 2.5), carbon-dioxated. This is a highly mineralized, sodic, muriated and bicarbonated, alkaline-saline (bromic, strontic) water, carbon-dioxated and sulphuretted, possessing diuretic, antacid, tonic and alterative properties.

Black Spring, medicinal classification, weak alkaline a or (−Aa), carbon-dioxated.

White Sulphur Spring, medicinal classification, weak alkaline a2 or (−Aa2).

These springs are so similar in the percentage of the predominating chemical constituents and amount of total solids that they may be classed as moderately mineralized, sodic, muriated and bicarbonated alkaline-saline water, carbon-dioxated and sulphuretted, possessing diuretic and antacid properties.

Main Chalybeate Spring, medicinal classification, very weak ferruginous 0.5 or (− −Fe 0.5), carbon-dioxated. This is a moderately

mineralized, calcic, sodic, bicarbonated alkaline-saline (ferruginous, baric) water, possessing active diuretic action and marked tonic action from the bicarbonate of iron. A valuable tonic in anemia and general debility.

OLYMPIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Robert Peter). | | | | | |
|---|---|---|---|---|---|---|
| | Salt Sulphur Spring. | Black Sulphur Spring. | White Sulphur Spring. | Main Chaly-beate Spring. | Salt Lick Spring. | Epsom Well Spring. |
| Lithium chloride (LiCl) | 0.80 | trace | trace | trace | trace | trace |
| Potassium chloride (KCl) | 35.50 | ... | ... | ... | 40.0 | |
| Sodium chloride (NaCl) | 4899.70 | 127.00 | 123.00 | 30.80 | 4710.0 | 830.0 |
| Magnesium chloride ($MgCl_2$) | 108.90 | ... | 7.10 | 3.10 | 120.0 | |
| Calcium chloride ($CaCl_2$) | 21.30 | ... | ... | ... | 20.0 | |
| Potassium sulphate ($K_2SO_4$) | ... | 3.10 | 13.30 | 12.50 | ... | 40.0 |
| Sodium sulphate ($Na_2SO_4$) | ... | 2.50 | 40.80 | ... | ... | 136.0 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | ... | 117.00 | ... | 260.0 |
| Calcium sulphate ($CaSO_4$) | trace | 6.10 | 3.90 | 55.40 | trace | 580.0 |
| Sodium bromide (NaBr) | 16.60 | ... | trace | | | |
| Sodium iodide (NaI) | trace | trace | trace | | | |
| Sodium bicarbonate ($NaCHO_3$) | 319.95 | 525.52 | 504.30 | ... | 372.00 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 532.98 | 25.59 | 120.52 | 161.67 | 291.6 | 1020.6 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 81.97 | 7.45 | 51.19 | 23.16 | 80.0 | 356.4 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace | trace | trace | trace | trace | trace |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 21.73 | ... | ... | ... | 16.2 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.91 | ... | ... | 39.20 | trace | trace |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 7.39 | ... | ... | ... | trace | trace |
| Aluminum oxide ($Al_2O_3$) | 0.60 | ... | 2.10 | ... | ... | trace |
| Phosphoric acid ($H_2PO_4$) | trace | trace | trace | trace | | |
| Sodium sulphite ($Na_2SO_3 + 7H_2O$) | trace | trace | trace | trace | | |
| Total solids | 6051.23 | 696.77 | 816.81 | 442.83 | 5649.8 | 20230. |
| Gases: | | | | | | |
| Carbon dioxide, cc. per liter | 240.1 | 278.0 | present | 121.0 | | |
| Hydrogen sulphide, cc. per liter | 1.1 | 1.2 | 1.1 | 1.3 | | |

Salt Lick Spring, medicinal classification, weak alkaline ab2, saline 2 or (−Aab2, Cl 2). This is a moderately highly mineralized, sodic, muriated and bicarbonated alkaline-saline (baric) water, possessing diuretic, tonic and weak aperient properties.

Epsom Well, medicinal classification, weak alkaline b4, weak saline 2, weak sulphate 3 or (−Ab4, −Cl 2, −S3). This is a highly mineralized, calcic bicarbonated and sodic muriated and sulphated alkaline-saline water, possessing diuretic and antacid properties.

## Phillips Well.

(*Hopkins County.*)

*Postoffice*, Dawson Springs. *Location*, in the western part of the state; east of Paducah, 50 miles; northwest of Bowling Green, 80 miles; south of Louisville, 166 miles; north of Hopkinsville, 30 miles. *Situation*, in the midst of a fertile valley, through which flows the Trade Wind River; this valley is surrounded by wooded hills and rugged cliffs, presenting a panorama of scenic beauty. *Access*, via Dawson Springs Station, on the main line of the Illinois Central Railway, thence about 150 yards to the wells. *Hotel*, this is an all-

year-round resort town. There are a number of modern hostelries, accommodating more than 1500 guests. There are 3 modern bathing establishments, equipped with every appliance for the latest practice of hydrotherapy and balneotherapy. The analysis of the water shows the following mineralization:

PHILLIPS WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). |
|---|---|
| Sodium chloride (NaCl) | 5.13 |
| Potassium chloride (KCl) | 190.49 |
| Sodium sulphate ($Na_2SO_4$) | 884.41 |
| Magnesium sulphate ($MgSO_4$) | 6127.96 |
| Potassium bicarbonate ($K[HCO_3]_2$) | 274.46 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 56.60 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 6.16 |
| Aluminum oxide ($Al_2O_3$) | 41.38 |
| Silica ($SiO_2$) | 119.54 |
| Total solids | 7706.12 |

Medicinal classification, sulphate 4 or (S4). This is a moderately highly mineralized, magnesic, sodic, sulphated, saline water, possessing diuretic and purgative properties. The predominating chemical constituents in this water are the sulphates of magnesium and sodium; of the former element it exceeds that of Friedrichshall, Saxe-Meiningen, Germany, and the celebrated Hunyadi Janos. It acts by causing copious watery stools. It is indicated in constipation and in catarrhal conditions of the alimentary tract. The waters are bottled and shipped extensively.

## Rock Castle Springs.

### (*Pulaski County.*)

*Postoffice*, Rock Castle. *Location*, in southeastern Kentucky; north of Knoxville, Tenn., 75 miles; south of Danville, 40 miles. *Situation*, on the Rock Castle River and in the valley of same in the heart of the Cumberland Mountains, at an elevation of 2000 feet above sea level. The situation is one of great natural charm and beauty. *Access*, via the Louisville & Nashville Railway and the Queen & Crescent route. *Hotel*, a comfortable hotel offers accommodations. The analysis below shows the mineralization:

ROCK CASTLE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. Peter). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 2.60 |
| Potassium sulphate ($K_2SO_4$) | trace |
| Sodium sulphate ($Na_2SO_4$) | 53.10 |
| Magnesium sulphate ($MgSO_4$) | 3.60 |
| Calcium sulphate ($CaSO_4$) | 2.90 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 23.97 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 70.95 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 23.24 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.50 |
| Silica ($SiO_2$) | 12.80 |
| Total solids | 194.66 |

The analysis shows this to be a lightly mineralized, calcic, ferric, magnesic, bicarbonated, alkaline water, possessing diuretic, antacid and tonic properties. The water is held in high esteem by the profession, who endorse it in the treatment of stomach, bladder and kidney affections, and especially in anemia and general debility.

### St. Patrick's Well.

*(Jefferson County.)*

*Postoffice,* 1382 So. Third St., Louisville. *Location,* in the center of the northern boundary of the state, on the southern bank of the Ohio River. *Situation,* in the city of Louisville, at the address given above. *Access,* via the various railway lines converging in this progressive city. *Hotels,* this city has a number of magnificent metropolitan hostelries. The following analysis shows the mineralization:

ST PATRICK'S WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). |
|---|---|
| Lithium chloride (LiCl) | 53.86 |
| Sodium chloride (NaCl) | 13,053.66 |
| Magnesium chloride ($MgCl_2$) | 1,093.20 |
| Potassium sulphate ($K_2SO_4$) | 257.18 |
| Magnesium sulphate ($MgSO_4$) | 127.39 |
| Calcium sulphate ($CaSO_4$) | 2,044.30 |
| Sodium bromide (NaBr) | trace |
| Potassium iodide (KI) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 440.78 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 70.61 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 45.77 |
| Silica ($SiO_2$) | 7.38 |
| Total solids | 17,194.10 |

Medicinal classification, strong saline 1.5, calcic sulphate or (+Cl1.5, CaS). A study of the analysis shows a highly mineralized, sodic, calcic and magnesic, muriated, sulphated, saline (strontic, ferruginous) water. This water possesses diuretic, antacid, laxative, tonic and alterative properties. The owner advises that the profession of Louisville endorse the water as of great value in the treatment of constipation and in digestive disturbances and also in catarrhal conditions of the alimentary tract.

The lithium and calcium sulphate exert a pleasing effect upon the genito-urinary tract and promptly relieve irritation of the bladder and renal organs. The bicarbonate of iron is a valuable hematinic, and is indicated in anemia, chlorosis and all run-down conditions, where an iron tonic is called for. The waters are bottled and shipped commercially throughout the state and adjoining territory.

### Upper Blue Lick Springs.

*(Nicholas County.)*

*Postoffice,* Blue Lick Springs, R. F. D., Maysville. *Location,* in northwestern Kentucky; south of Covington, 62 miles; north of Mt.

Sterling, 18 miles. *Situation*, in the valley of the Licking River, at an elevation of about 1800 feet above sea level. *Access*, Maysville & Lexington Railway to within 6 miles of the springs, thence by motor. *Hotel*, no authentic information available concerning accommodations. The following analysis shows the mineralization.

UPPER BLUE LICK SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, A. F. Judge). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 30.78 |
| Sodium chloride (NaCl) | 8,832.66 |
| Magnesium chloride ($MgCl_2$) | 645.01 |
| Calcium chloride ($CaCl_2$) | 8.55 |
| Magnesium bromide ($MgBr_2$) | 64.98 |
| Magnesium iodide ($MgI_2$) | 2.56 |
| Potassium sulphate ($K_2SO_4$) | 221.78 |
| Calcium sulphate ($CaSO_4$) | 754.61 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 4.27 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 3.87 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 694.21 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 20.49 |
| Silicic acid ($SiO_3$) | 17.10 |
| Total solids | 11,300.77 |
| Temperature, °C. | 17.2 |
| Gases: | |
| Carbon dioxide, cc. per liter | 166.4 |
| Hydrogen sulphide, cc. per liter | 28.8 |
| Flow in gallons per day | 28,000 |

Medicinal classification, weak alkaline b2, strong saline, weak calcic sulphate 2, iodic or (−Ab2, +Cl, −CaS2, I), carbon-dioxated, sulphuretted. The analysis shows this to be a highly mineralized, sodic, magnesic, muriated, calcic, potassic, sulphated, bicarbonated saline (bromic, iodic, phosphatic) water, carbon-dioxated, sulphuretted, possessing diuretic, antacid, aperient and alterative properties. Their administration in engorgements of the liver and abdominal organs, gall stones, gastric catarrh, intestinal stasis, constipation, etc., have given satisfactory results.

The following springs were once popular resorts:

*Bedford Springs, P. O.*, Bedford Springs, Trimble County. Hotel and cottages. There are 3 springs in this area, but no definite information nor satisfactory analysis available.

*Buena Vista Springs, P. O.*, Russelville, Logan County. Hotel is situated on Elk Lick Creek. Formerly known as Elk Lick Springs. At one time it is said the water was highly endorsed by Kentucky physicians, but no definite information nor satisfactory analysis is available.

*Drenon Springs, P. O.*, New Castle, Henry County. This was an old-time resort. Hotels and cottages were destroyed by fire a quarter

of a century ago and the place allowed to languish. No other information possible nor satisfactory analysis available.

*Esculapia Springs, P. O.*, Esculapia Springs, Lewis County. No definite information nor satisfactory analysis available.

*Fox Springs, P. O.*, Flemingsburg, Fleming County. No definite information nor satisfactory analysis available.

*White Sulphur Springs, P. O.*, Cloverport, Breckenridge County. Hotel and cottages. Four springs, all said to be sulphuretted. No definite information nor satisfactory analysis available.

The following reported the sale of water in 1924:

*Anita Springs, P. O.*, La Grange, Oldham County.

*Avonmore Hotel Spring*, Dry Ridge, Grant County.

*Cole's Lithia Springs, P. O.*, Lexington, Fayette County.

*Glen Lily Springs, P. O.*, Bowling Green, Warren County.

*H. & H. Well, P. O.*, Dawsonsprings, Hopkins County.

*Robson Springs, P. O.*, Fort Thomas, Campbell County.

*Stevens Well, P. O.*, Dawsonsprings, Hopkins County.

## LOUISIANA.

Louisiana extends from 29° to 33° north latitude and from 89 west longitude on the east to 94° on the west longitude, and comprises an area of 48,720 square miles, of which 3300 square miles are under water. Of the water area 1700 square miles is made up of inland lakes, 1060 square miles of land-locked bays, often called lakes, and 540 square miles of river surface. Throughout the entire extent of the state the surface is an alluvial plain. Much of the territory of the portion bordering on the Mississippi is much below the surface of the water in the river, and is protected from inundation by dykes or levees, there being more than 1500 miles of such embankments to hold the water on the river bed. The land slopes imperceptibly to the southeast. The highest elevation at the Arkansas line is 130 feet; at Natchez, 66 feet; at Baton Rouge, 34 feet, at New Orleans, 15 feet. The climate is warm, but the winters are cold and more variable than in the same latitude on the Atlantic coast. The mean annual temperature, as observed at New Orleans, is 20.1° C. (69.06° F.), that of the summer being 27° C. (81.08° F.) and of the winter 13.3° C. (56° F.); absolute −17.8° C. (0° F.) has been observed in the extreme northwest corner of the state, thus giving a range of almost 37.8° C. (100° F.) in temperature.

Louisiana has 15 spring localities, with a total of 28 individual springs, none of which have any satisfactory analysis. The available information concerning the mineral springs of Louisiana is meagre and the list here given is presumably incomplete. Walton gives only 2 spring localities and Crook mentions 5; Peale lists 15, but says they are of only local importance.

### Ozone Springs.

*(St. Tammany's Parish.)*

*Postoffice*, Pearle River. *Location*, in eastern Louisiana, 1 mile from the Mississippi boundary line; north of New Orleans, 30 miles; south of Jackson, Miss., 140 miles. *Situation*, in the valley through which runs the lazy Pearl River, all lying in the famous ozone belt of St. Tammany's Parish. The climate is mild, equable and salubrious. *Access*, via the New Orleans & Eastern Railway, and over the splendid highways by motor. *Hotel*, there is a modern resort hostelry. The water filters through beds of sand and gravel and issues forth with high pressure, sufficient to lift it into tanks and tank cars, which transport it to the bottling plant in New Orleans. The analysis below shows the mineralization, which resembles closely that of the celebrated Grand Grille at Vichy, France, though in a less concentrated form:

OZONE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. J. C. Mimms). |
|---|---|
| Potassium sulphate ($K_2SO_4$) | trace |
| Sodium sulphate ($Na_2SO_4$) | 10.55 |
| Sodium bicarbonate ($NaHCO_3$) | 207.80 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 7.73 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 27.92 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.66 |
| Aluminum oxide ($Al_2O_3$) | 6.85 |
| Silica ($SiO_2$) | 30.70 |
| Total solids | 295.11 |

This is a lightly mineralized, sodic, calcic, bicarbonated, alkaline (ferruginous, aluminic) water, possessing diuretic, antacid and tonic properties. The waters are highly endorsed by the profession in the treatment of the rheumatic diathesis and in renal and vesical disorders. The waters are sold principally as a table water in the city of New Orleans.

The following springs were once popular resorts:

*Clairborne Springs, P. O.*, Covington, St. Tammany Parish. No definite information nor satisfactory analysis available.

*De Soto Mineral Springs, P. O.*, Longstreet, De Soto Parish. This was a popular resort sixty years ago; the situation is delightful, and the waters were believed to have exceptional merit. No definite information nor satisfactory analysis available.

*White Sulphur Springs, P. O.*, White Sulphur Springs, Catahoula Parish. There were 4 springs in this area, with a combined flow of 30,000 per minute. The water was used with benefit in rheumatism, dyspepsia, etc. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Krotz Springs, P. O.*, Krotz Springs, St. Laundry Parish.

## MAINE.

Maine extends from 43°5′ to 47°30′ north latitude and from 66°50′ to 71° west longitude, and embraces an area of 33,040 square miles, of which 3145 square miles are under water. The topography of the state is generally hilly, becoming mountainous in the west and north; the highest elevation, east of the Kennebec, is 1500 feet above sea level. Spurs of the Appalachian Mountains invade the state, and on the extreme west this range rises to a height of 2000 feet above sea level; other peaks are Mount Katahdin (5200 feet high), Mount Abraham (3388 feet high) and Mount Bigelow (3600 feet high). There are about 600 lakes scattered over the northern portion of the state, and they total about 2300 square miles of area. They lie for the most part in the plateau region, and many of them are of great natural beauty. Moosehead Lake is the largest, 120 square miles in extent, the largest inland body of water in New England, and the source of the Kennebec River; the Rangley Lakes, with an area of 90 square miles, form the head-waters of the Androscroggin River. The climate is healthful and invigorating; the winters, although long and severe, are not subjected to injurious variations, while the summers are pleasant. The mean annual temperature at Portland is 6° C. (43° F.); the winters, 1.5° C. (31.69° F.); the summers, 17.5° C. (63.73° F.). These figures are the average calculated from observations covering a period of thirty-seven years. The anticyclones and north winds of midwinter bring an average winter temperature of −28.9° C. (20° F. below zero), around Eastport and Augusta, while in the vicinity of Mount Katahdin the temperature falls to −34.4° C. (30° F. below zero.)

Maine has 41 spring localities, with a total of 49 individual springs, 20 of which have been analyzed, and at various times used as resorts. The mineral springs of the state belong to the class of alkaline-saline and chalybeate waters, the latter predominating. Many are sulphuretted and a few carbonated. None of them are thermic, though some of them have a temperature of 10° C. (50° F.). Of late years the springs of Maine have attracted considerable attention. Walton mentions but 1 locality and some of the older works on mineral waters do not mention any. Crook mentions 7 spring localities and Peale records 9 localities. The list given herewith, obtained from personal correspondence with physicians and spring owners, gives a fair account of the active springs in use at the present time.

### Glenwood Spring.

*(Somerset County.)*

*Postoffice,* St. Albans. *Location,* slightly southwest of central Maine; northeast of Augusta, the capital city, 80 miles; northwest of Bangor, 35 miles; south of Moosehead Lake, 40 miles. *Situation,* in Maine's

beautiful lake region, amid charming surroundings of wooded hills and pleasing valleys. The spring issues from deep igneous rocks far below the surface; situated on a slightly elevated tableland, about 750 feet above tide water. The elevation of the spring commands a beautiful diversified view of the surrounding landscape. *Access*, via the Maine Central Railway. *Hotel*, there are good hotels in St. Albans and also at Hartland, not far distant. The analysis below shows the mineralization:

GLENWOOD SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.03 |
| Potassium chloride (KCl) | 1.77 |
| Sodium chloride (NaCl) | 1.57 |
| Sodium sulphate ($Na_2SO_4$) | 5.34 |
| Sodium nitrate ($NaNO_3$) | 2.12 |
| Sodium bicarbonate ($NaHCO_3$) | 3.65 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 14.96 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 52.60 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.50 |
| Silica ($SiO_2$) | 11.00 |
| Total solids | 93.54 |
| Temperature, °C. | 8.9 |
| Flow in gallons per day | 10,800 |

The analysis shows a lightly mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic and antacid properties. Approximately 76 per cent of the salts in solution are in the form of the bicarbonates of calcium, magnesium and sodium, and 6 per cent of sodium sulphate. It is a remarkably pure, wholesome, potable water, and useful in the treatment of mild inflammatory irritations of the genito-urinary tract. In the mild gastric disturbances due to acidity this water is admirable.

## Highland Spring.

(*Androscoggin County.*)

*Postoffice*, Lewiston. *Location*, in the southwestern portion of the state; north of Portland, 30 miles; southwest of Augusta, the capital city, 30 miles. *Situation*, in Highland Park, a beautiful spot comprising more than 60 acres of rolling dales and wooded knolls. *Access*, via Lewiston Station on the Maine Central Railway, thence by motor 2 miles to the springs. *Hotel*, no accommodations for guests, but a few cottages are available for housekeeping visitors. The following analysis shows the mineralization:

HIGHLAND SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.061 |
| Lithium chloride (LiCl) | |
| Potassium chloride (KCl) | 2.30 |
| Sodium chloride (NaCl) | 1.770 |
| Sodium sulphate ($Na_2SO_4$) | 6.440 |
| Magnesium sulphate ($MgSO_4$) | 0.380 |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 5.170 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 23.690 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.110 |
| Silica ($SiO_2$) | 11.400 |
| Total solids | 52.321 |

The analysis shows this to be a slightly mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated; the analysis also shows that 55 per cent of the chemical constituents in solution are in the form of the bicarbonates of calcium and magnesium, and approximately 12 per cent of sodium sulphate. The water possesses diuretic and antacid properties, and ought to be serviceable in the treatment of digestive disturbances due to acidity and in the milder forms of irritations of the genito-urinary tract.

## Keystone Mineral Spring.

*(Androscoggin County.)*

*Postoffice,* East Poland. *Location,* in the southwestern portion of the state; north of Portland, 30 miles; 6 miles each from Lewiston and Auburn. *Situation,* on an elevated ridge about 800 feet above sea level, at the beginning foothills of the White Mountains, which form an impressive background for the setting of a picturesque scene of sylvan beauty. The spring issues forth from a bed of igneous rock much like granite formation and scarcely discernible from it. *Access,* via Poland Station on the Empire Railway, branch of the Maine Central, thence 1 mile to the spring; via Portland & Rumfort Falls Railway, 2 miles distant from the spring. *Hotels,* no accommodations for guests. The following analysis shows the mineralization:

KEYSTONE MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Potassium chloride (KCl) | 1.60 |
| Sodium chloride (NaCl) | 7.33 |
| Sodium sulphate ($Na_2SO_4$) | 3.14 |
| Magnesium sulphate ($MgSO_4$) | 1.64 |
| Sodium nitrate ($NaNO_3$) | 1.20 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 16.68 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 59.50 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.24 |
| Silica ($SiO_2$) | 11.60 |
| Total solids | 103.93 |

An examination of the analysis shows this to be a lightly mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated, possessing antacid and diuretic and slight tonic properties. The predominating elements in solution (73 per cent) are in the form of the bicarbonates of calcium and magnesium, with 7 per cent of sodium chloride and 3 per cent of sodium sulphate. The water is recommended in gastric disturbances due to acidity and as a mild unstimulating beverage in slight inflammatory renal and bladder complaints. The waters are sold commercially; flow, 66 gallons per minute.

## Mount Hartford Lithia Springs.

(*Oxford County.*)

*Postoffice,* Hartford. *Location,* in southwestern Maine; west of Augusta, the capital city, 29 miles; north of the celebrated Poland Springs, 20 miles. *Situation,* among the outlying foothills on the eastern slope of the White Mountains, which form an impressive background in the distant western horizon. The spring is situated amidst a slightly elevated tableland, about 600 feet above tide water. *Access,* via the Maine Central and Canadian National Railways. *Hotel,* there are good accommodations at Hartford. The spring issues from deep igneous rock, and the surroundings are such as to insure against contamination. The analysis below shows the mineralization:

MOUNT HARTFORD LITHIA SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 1.44 |
| Sodium chloride (NaCl) | 5.48 |
| Sodium sulphate ($Na_2SO_4$) | 2.40 |
| Sodium nitrate ($NaNO_3$) | 1.20 |
| Sodium bicarbonate ($NaHCO_3$) | 2.52 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 6.19 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 17.91 |
| Silica ($SiO_2$) | 9.00 |
| Total solids | 46.14 |
| Temperature, °C. | 4.0 |
| Flow in gallons per day | 14,400 |

The analysis shows this to be a slightly mineralized, calcic, magnesic, sodic, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic and antacid properties. This water is of low mineralization and remarkable purity. Approximately 58 per cent of the salts in solution are in the form of the bicarbonates of calcium, magnesium and sodium, with 12 per cent of sodium chloride and 5 per cent of sodium sulphate. Waters of low mineralization often produce pleasing therapeutic results, which the predominating chemical constituents

would not indicate; this pleasing action may be accounted for, in part, by the perfect solution of the contained salts, which solutions, though dilute, are most active; again, in waters not so highly mineralized the degree of ionization is more perfect, for it is a noteworthy fact that the degree of ionization is in proportion to the dilution of the solution, and after all it is the action of the ions rather than the salts *per se* which produce curative results.

## Mount Zircon Spring.

### (*Oxford County.*)

*Postoffice*, Rumford. *Location*, in the midwestern section of the state, about 15 miles east of the New Hampshire boundary line; northwest of the capital city, Augusta, about 40 miles; north of Portland, about 90 miles. *Situation*, in a beautiful mountain lake region of rolling hills and beautiful valleys; Mount Zircon rises high above the surrounding country, 2700 feet above sea level. In a niche, carved by the hand of Nature, in the side of this mountain, about two-thirds the way up from the base, gushes forth from great depths potable water, clear as crystal, sparkling with purity, always the same temperature. The scenic beauty of Mount Zircon and its environs is unsurpassed in any section of New England; from the summit of this mountain, looking northward, the eye scans the beautiful Rangeley Lakes, 40 miles away; to the west appears the White Mountains; to the southward on a clear day one can see Portland Harbor, and to the east the vista of the beautiful Webb Lake country, surrounded by the grandest and most beautiful mountains in the state. *Access*, via Rumfort Depot on the Rangeley Lakes Branch of Maine Central Railway, thence by motor 4 miles to the springs, or via national highways, perfect motor roads connecting with the White Mountain trails. *Hotels*, there was a large hotel here at one time, and the place was famous as a resort for those in search of health and recreation, but the hotel was burned and never rebuilt. A recent analysis of the Mount Zircon water shows the following mineralization:

MOUNT ZIRCON SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. W. Campbell). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.015 |
| Potassium chloride (KCl) | 1.335 |
| Sodium chloride (NaCl) | 1.375 |
| Sodium sulphate ($Na_2SO_4$) | 1.632 |
| Magnesium sulphate ($MgSO_4$) | 1.875 |
| Sodium nitrate ($NaNO_3$) | 0.364 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 13.700 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1.268 |
| Ferric oxide ($Fe_2O_3$) | 0.050 |
| Silica ($SiO_2$) | 15.780 |
| Total solids | 37.394 |

This is a slightly mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated, flowing at a normal rate of 23,000 gallons daily, except at the full moon, when the flow increases to 30,000 gallons daily. The name "Moon Tide Spring" is an appellation given this spring by the Indians. To the red man the moon was next to the sun in his mysterious worship. With them the sun numbered the days and the moon the months; to give the name Moon Tide to this spring and its wonderful water was a sure token of their appreciation of its wonderful therapeutic properties. The Mount Zircon Spring water is highly endorsed by local physicians in gastro-intestinal disorders, in irritation of the genito-urinary tract and in rheumatic disorders. The water possesses diuretic, antacid and solvent properties. The waters are bottled and sold extensively throughout southwestern Maine.

## Pine Spring.

### (*Sagadahoc County.*)

*Postoffice*, Topham. *Location*, in southwestern Maine; south of Augusta, the capital city, 33 miles; east of the celebrated Poland Springs, 35 miles. *Situation*, in the coastal region, about 40 miles inland, nestled in a sequestrated spot, about 450 feet above sea level, and overlooking a rolling undulating section of country, presenting pleasing vistas to the eye. On a clear day, with a field glass, the harbor at Bath may be clearly seen. *Access*, via the Maine Central Railway, thence only a short distance to the spring. *Hotel*, there are no provisions at the springs for accommodating guests, but there are fairly good hotels in the nearby vicinity. The analysis below shows the mineralization:

PINE SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.08 |
| Potassium chloride (KCl) | 1.14 |
| Sodium chloride (NaCl) | 5.96 |
| Sodium sulphate ($Na_2SO_4$) | 1.55 |
| Sodium bicarbonate ($NaHCO_3$) | 2.33 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 4.75 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 8.65 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.02 |
| Silicate ($SiO_2$) | 7.40 |
| Total solids | 32.80 |
| Temperature, °C. | 7.8 |
| Flow in gallons per day | 7200 |

The analysis shows a slightly mineralized, sodic, muriated, bicarbonated, alkaline-saline water, carbon-dioxated. Approximately 48 per cent of the salts in solution are in the form of bicarbonates, with 18 per cent of sodium chloride and 5 per cent of sodium sulphate. This water possesses diuretic, antacid, slight laxative and tonic properties. The waters are bottled and shipped commercially.

## Paradise Spring.

(*Cumberland County.*)

*Postoffice*, Brunswick. *Location*, in the costal region of the state, near Bowdoin College, 1 mile west of Brunswick; south of Augusta, the capital city, 35 miles. *Situation*, in a region of undulating savannas, about 300 feet above tide water. *Access*, via the Maine Central Railway to Brunswick, thence 1 mile by motor to the spring. *Hotels*, no accommodation for guests at the springs, but good hotels in Brunswick. The spring gushes from the earth in a wooded dell not far from the campus of Bowdoin College. It is said that when Hawthorne and Longfellow were students at Bowdoin College, in 1825, this spring was one of their favorite haunts. The stream flowing from this spring was named Hawthorne Brook, which appellation it still bears Paradise Spring has been known and its waters continuously used for more than one hundred years. At the Bowdoin College commencement in 1835 the class poet wrote and recited the poem, "Paradise Spring," which indicates the regard with which the spring and its waters were held at that time. The analysis below shows the mineralization:

PARADISE SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Henry Carmichael). |
|---|---|
| Sodium chloride (NaCl) | 0.377 |
| Potassium chloride (KCl) | 0.617 |
| Calcium sulphate ($CaSO_4$) | 1.028 |
| Sodium bicarbonate ($NaHCO_3$) | 9.774 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1.786 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 2.054 |
| Ferric oxide ($Fe_2O_3$) | 0.086 |
| Silica ($SiO_2$) | 6.492 |
| Total solids | 22.214 |

Carbon dioxide ($CO_2$), free, small amount after combining with carbonates.

A careful examination of the above analysis shows a very slightly mineralized, sodic, calcic, bicarbonated, alkaline water. It bursts forth from the spring sparkling in all its purity, laden with natural carbonic-acid gas, which adds to its therapeutic and solvent action. An exhaustive comparison of the analyses of the various mineral waters of the United States shows this to be one dominantly superior natural water of the lowest mineralization, found in this country. This water possesses marked diuretic action with eliminative properties, and the physician who wants to prescribe a practically pure water for his patient need not search any farther, as this is the lowest in mineral content of any water that has been brought to the attention of the author.

## Poland Spring.

(*Androscoggin County.*)

*Postoffice*, South Poland. *Location*, in southwestern Maine; north of Portland, 27 miles; southwest of Augusta, the capital city, 42 miles; west of Lewiston, 12 miles. *Situation*, among the foothills of the eastern slope of the White Mountains, which form an impressive background in the distant northwestern horizon, while to the eastward a wide panorama of wonderful charm and beauty is presented to the view of the beholder. The situation of this well-known spring is upon a tableland, 800 feet above sea level, and somewhat higher than the adjacent surroundings, thus allowing no opportunity for surface contamination. *Access*, via the Maine Central Railroad and the Canadian National Railway at Danville Junction (Maine). Through service by rail via the New York, New Haven & Hartford Railway, Boston, Maine and Maine Central Railway to Danville Junction, thence by motor bus to the hotel. *Hotel*, three splendid hotels, all under one management, open throughout the year, comprise one of the finest resort developments, possibly, in the world.

The Poland Spring gushes from a fissure of porphyritic rock, composed principally of gneiss and mica shists, scarcely distinguishable from the original granite, and older by far than the red sandstone which, according to geologists, is the oldest of the sedimentary rocks. All indications point to the fact that the water comes from great depths below the earth's surface, and is a juvenile or virgin water, and such waters are usually highly radio-active. The walls of the spring on each side of the fissure are of everlasting granite. The extent and peculiar geological character of the intervening strata account, in part, for the unparalleled purity of the water, and its remarkably low mineralization is shown by the analysis given below, being recalculated from Professor Chandler's original analysis:

POLAND SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. F. Chandler). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.03 |
| Potassium chloride (KCl) | 2.31 |
| Sodium chloride (NaCl) | 2.06 |
| Magnesium chloride ($MgCl_2$) | 0.54 |
| Magnesium sulphate ($MgSO_4$) | 1.86 |
| Sodium nitrate ($NaNO_3$) | 7.27 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 13.02 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 34.24 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 19.26 |
| Total solids | 80.59 |
| Temperature, °C. | 7.8 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 2.1 |
| Carbon dioxide set free on evaporation, cc. per liter | 10.2 |
| Hydrogen sulphide, none. | |
| Flow in gallons per day | 6000 |

The analysis shows this to be a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water, slightly carbon-dioxated, possessing antacid and diuretic properties. The therapeutic value of this water has been known to the medical profession for nearly half a century, and the archives of the owners contain a large volume of testimony of its successful administration in the treatment of rheumatism and kindred diseases and in different forms of kidney and liver disturbances. Many medical authorities, including such eminent authors as Sir William Osler, Prof. Hobart Amory Hare and Dr. Frederick Forcheimer, have recommended the use of this water in a variety of pathological conditions.

It is not surprising therefore that Poland Water has enjoyed an enduring and lasting popularity not only in the United States, but all over the world. (See Chapter XV.)

The following were once used as resorts:

*Addison Mineral Springs, P. O.*, Addison, Washington County. This is a very large spring, 5 feet in diameter and 4 feet in depth, with a very bold flow. It is a slightly alkaline chalybeate water. There was once a good hotel here and the place was very popular as a resort. No definite information nor satisfactory analysis is available.

*Blue Hill Mineral Springs, P. O.*, Blue Hill, Hancock County. This is also a slightly alkaline chalybeate water, issuing from the base of Blue Hill Mountains. There was once a good hotel here, and the place was a favorite resort for New England families. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "out of business."

*Booth Bay Mineral Spring, P. O.*, East Booth Bay, Lincoln County. This was once a resort. The spring has a flow of 300 gallons per minute, sulphuretted. No definite information or satisfactory analysis available.

*Pownal Spring, P. O.*, West Pownal, Cumberland County. This spring is situated near the foothills of the White Mountains and was a popular resort in years gone by. The water is of very light mineralization. No definite information or satisfactory analysis available.

*Underwood Springs, P. O.*, Falmouth Foreside, Cumberland County. These springs are located on the shores of Casco Bay, with a flow of 200,000 gallons per day. It is said to have been discovered by Weymouth, the English explorer. No definite information or satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Baker Puritan Springs, P. O.*, Old Orchard, York County.

*Crystal Spring, P. O.*, Skowhegan, Somerset County.

*Glenrock Cold Spring, P. O.*, Greene, Androscoggin County.

*Hanover Spring, P. O.*, Hanover, Oxford County.

*Holbrook Hill Spring, P. O.*, Pittsfield, Somerset County.

*Indian Hermit Mineral Spring, P. O.*, Wells, York County.

*Mount Desert Spring, P. O.*, Mount Desert, Hancock County.
*Mount Kebo Spring, P. O.*, Bar Harbor, Hancock County.
*Mystic Spring, P. O.*, Saco, York County.
*Oak Grove Spring, P. O.*, Brewer, Penobscot County.
*Rocky Hill Spring, P. O.*, Fairfield, Somerset County.
*Thorndike Mineral Spring, P. O.*, Thorndike, Waldo County.
*Wawa Lithia Spring, P. O.*, Wells, York County.

## MARYLAND.

Maryland extends from 37°43′ to 39°45′ north latitude and from 75°10′ to 79°30′ west longitude, and comprises an area of 12,210 square miles, of which 2350 square miles are water. The outline of the state is extremely irregular, as the northern boundary is mainly a winding river, and the western part of the state is a long fragment, lying between the Potomac River and the Mason and Dixon line. The extreme length of the northern boundary is 21.5 miles, with a further extension of 35 miles, where the state stretches eastward, south of Delaware, to the Atlantic Ocean. The extreme breadth of the state from north to south, near the eastern shore of the Chesapeake, is 128 miles. The state is divided into two unequal parts by the Chesapeake Bay. The surface of the eastern shore is almost level, and is in parts swampy, but toward the north it is hilly and broken; the northwest is mountainous, being traversed by six ranges of the Alleghenies. The most conspicuous feature of the Atlantic Plain of Maryland is the Chesapeake Bay, which has about two-thirds of its entire length of 200 miles within the state. The climate of the state is mild and healthful, being tempered by the proximity of the prevailing winds from the Atlantic Ocean. The mean annual temperature, as observed at Baltimore, is 13° C. (54.91° F.); that of the summer, 24° C. (75.8° F.); of the winter, 2° C. (34.5° F.); an extreme winter temperature has been recorded at Sunnyside in the Allegheny Plateau of −32.2° C. (26° F. below zero), and a summer temperature of 38.9° C. (103° F.) near Cumberland.

Maryland has 29 spring localities, with a total of 101 individual springs, 4 of which have been analyzed. The general works on mineral springs give little attention to the springs of Maryland. Pepper's list names but 1 locality, Walton mentions none and Crook's work lists 5 localities. Several spring localities once extensively used for resort purposes have long since been abandoned. The nearness of many of the springs in this state to Virginia has probably caused them to be neglected, as this state has become exceedingly popular for its spring resorts. The principal waters in Maryland are chalybeate, the majority are unimproved and unimportant. The list given herewith has been obtained through correspondence with physicians and spring owners and from printed sources, etc., and we believe fairly represents the active springs in use today.

## Bently Springs.

(*Baltimore County.*)

*Postoffice*, Bently Springs. *Location*, in central Maryland; north of Annapolis, the capital city, 45 miles; southwest of Wilmington, Del., 55 miles. *Situation*, in a gently rolling region, at an elevation of about 600 feet above sea level. *Access*, via Northern Central Railway Division of the Pennsylvania Railroad. *Hotel*, there is a comfortable resort hostelry, with modern conveniences. There are a number of springs in this area, of which we present the analysis of 2 of the more prominent:

BENTLY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. Aiken). | |
|---|---|---|
| | Station Spring. | Lower Spring. |
| Ammonium chloride ($NH_4Cl$) | trace | trace |
| Sodium chloride ($NaCl$) | 3.24 | 7.47 |
| Calcium sulphate ($CaSO_4$) | 5.10 | 5.99 |
| Sodium bicarbonate ($NaHCO_3$) | 13.49 | 12.74 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 7.47 | 18.83 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | trace | 24.55 |
| Aluminum oxide ($Al_2O_3$) | 0.34 | 0.51 |
| Silicic acid ($H_2SiO_3$) | 5.64 | 7.35 |
| Total solids | 44.69 | 95.23 |

The Station Spring is a slightly mineralized, sodic and calcic, bicarbonated, alkaline water, possessing diuretic and antacid properties.

The Lower Spring is a lightly mineralized, ferric, sodic, calcic, bicarbonated alkaline water, possessing diuretic, antacid and tonic properties. These waters have been used for a half century in the treatment of diseases of the kidney, liver and stomach disorders. The waters are sold commercially.

## Chattolanee Springs.

(*Baltimore County.*)

*Postoffice*, Garrison. *Location*, in central Maryland; north of Annapolis, the capital city, 50 miles; southwest of Wilmington, Del., 60 miles. *Situation*, in Green Spring Valley, in a beautiful rolling region of hills and dales, at an elevation of 500 feet above sea level. *Access*, via the Northern Central Railway. *Hotel*, there is a resort hostelry which sits atop a rounded hill 130 feet above the springs and has an elevation above tide water of 625 feet, and offers all the conveniences and comforts of a modern establishment of the first class. The analysis below shows the mineralization:

CHATTOLANEE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Lehman & Mager). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Sodium chloride (NaCl) | 1.88 |
| Magnesium chloride ($MgCl_2$) | 3.59 |
| Potassium sulphate ($K_2SO_4$) | 1.71 |
| Sodium sulphate ($Na_2SO_4$) | 1.36 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 60.11 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 127.95 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 4.00 |
| Total solids | 200.70 |

The analysis shows this to be a lightly mineralized, calcic, bicarbonated, alkaline water, possessing diuretic and slight antacid properties, and is used successfully in the treatment of digestive disturbances and in the early stages of Bright's disease. It is a delightful table water, and is used extensively in the city of Baltimore.

## Flint Stone Mineral Springs.

(*Allegheny County.*)

*Postoffice,* Flintstone. *Location,* in northwestern Maryland; west of Hagerstown, 50 miles; east of Cumberland, 12 miles; south of Bedford, Pa., 25 miles. *Situation,* in the valley of Flint Stone Creek, on the eastern slope of the Allegheny Mountains, at an altitude of about 820 feet above sea level. *Access,* Baltimore & Ohio and the Chesapeake & Ohio Railways and connections. *Hotel,* there is a modern resort hostelry, with ample accommodations. There are a number of springs in this area; the analysis of 1 is given herewith:

FLINT STONE MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst unknown). |
|---|---|
| Potassium chloride (KCl) | 25.14 |
| Sodium chloride (NaCl) | 60.36 |
| Potassium bromide (KBr) | 0.13 |
| Potassium iodide (KI) | 1.35 |
| Magnesium sulphate ($MgSO_4$) | 671.52 |
| Calcium sulphate ($CaSO_4$) | 1474.19 |
| Barium sulphate ($BaSO_4$) | 4.38 |
| Strontium sulphate ($SrSO_4$) | 6.27 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 355.70 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 3.96 |
| Silica ($SiO_2$) | 393.81 |
| Total solids | 2996.81 |

Medicinal classification, weak alkaline b, calcic sulphate (iodic) or (−Ab, CaS[I]). The analysis shows this to be a moderately highly mineralized, calcic, magnesic, sulphated and bicarbonated saline water, possessing diuretic, tonic and alterative properties. The waters are highly

recommended for gastric irritation, stasis of the bowels and in kidney and liver affections. The waters are sold commercially, and legend has it that the red men of the forest centuries before the coming of the pale face resorted here to slake their thirst with the "medicine waters," and imparted their knowledge to the first pioneers who penetrated the woods, and finally left behind them their disease-curing and health-giving springs.

### Mardela Springs.

(*Wicomico County.*)

*Postoffice,* Mardela Springs. *Location,* in southern Maryland; southeast of Annapolis, the capital city, 55 miles; southeast of Cambridge, 15 miles; north of Pocomoke City, 20 miles. *Situation,* on the eastern shore of the Chesapeake Bay, at an elevation of 200 feet above sea level. *Access,* via the Baltimore & Atlantic Railway. *Hotel,* there is said to be a commodious resort hostelry, but no detailed information is available; these springs were formerly known as Barren Creek Springs. The analysis below shows the mineralization:

MARDELA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, P. B. Wilson). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 13.33 |
| Calcium sulphate ($CaSO_4$) | 0.17 |
| Sodium bicarbonate ($NaHCO_3$) | trace |
| Magnesium sulphate ($MgSO_4$) | 1.10 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 37.39 |
| Sodium arsenate ($Na_3AsO_4$) | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 202.46 |
| Silica ($SiO_2$) | 21.88 |
| Total solids | 276.33 |

The analysis shows this to be a lightly mineralized, ferric, alumnic, alkaline-saline (arsenated) water, possessing diuretic, tonic and alterative properties. The water is a weak chalybeate. It is a very efficient tonic and diuretic, and contains sufficient arsenic to give it valuable alterative properties. It promotes the appetite, aids the digestion and increases the general powers of nutrition. It is highly recommended by physicians of Baltimore in cases of weakness and irritability of the bladder, anemia, chlorosis, dyspepsia, chronic cystitis, urethritis, amenorrhea and other functional disorders of the female pelvic organs, when due to debility. The water is found in the Baltimore markets.

The following springs were at one time used as health and pleasure resorts; for one reason or another they have, of late years, passed into obscurity:

*River Springs, P. O.,* River Springs, St. Mary's County. This place was used as a resort as late as 1886, and there are quite a number of

springs in this locality, most of them chalybeate in character. At the present time no definite information nor satisfactory analysis available.

*The Spa Spring, P. O.*, Bladensburg, Prince George's County. This is a saline-chalybeate water, of a good strong flow. At the present time no definite information nor satisfactory analysis available.

*Strontia Mineral Spring, P. O.*, Strontia Station, Baltimore County. These springs are located about 10 miles from the center of the city of Baltimore, and were generally patronized by the citizens of Baltimore some decades ago. At the present time no definite information or satisfactory analysis available. Correspondence returned marked "unknown."

The following springs reported the sale of water during 1924:

*Big Rock Spring, P. O.*, Thurmont, Frederick County.
*Brooklandwood Spring, P. O.*, Brooklandville, Baltimore County.
*Buena Vista Spring, P. O.*, Edgemont, Washington County.
*Caton Spring, P. O.*, Catonsville, Baltimore County.
*Conroy Spring, P. O.*, Branchville, Prince George's County.
*Gray Rock Spring, P. O.*, Woodlawn, Baltimore County.
*Green Springs, P. O.*, Big Spring, Washington County.
*Hygeia Crystal Springs, P. O.*, Annapolis, Anne Arundel County.
*Rock Spring, P. O.*, Gapland, Washington County.

## MASSACHUSETTS.

Massachusetts extends from 41°15′ to 42°55′ north latitude, and from 69°56′ to 73°31′ west longitude, and embraces an area of 8315 square miles, of which the water surface amounts to 275 square miles. The irregular coast line gives an ocean frontage of near, 300 miles. The eastern section is a rolling hilly country with a gentle slope toward the ocean. From Vermont, the Green Mountains, as a part of the Appalachians, continue southward into this state, where they lie in two distinct ranges, the Berkshire Hills and the Hoosac Mountains. The highest elevation in the state is in the Taconic Range, 3535 feet above sea level. The Housatonic Valley has an elevation of 1100 feet above sea level. There are numerous small lakes throughout the state. On the coast are thirty-nine islands, the largest is Nantucket and the second being Martha's Vineyard. Many elegant and popular summer resorts are found all along the coast. The climate is rugged, but of a salubrious character; the winters are long and severe, while the summers are warm but short. The mean annual temperature, as observed at New Bedford during a period of fifty-eight years, is 10° C. (48.56° F.); that of the summer, 19° C. (66.95° F.); of the winter, 1.5° C. (30.21° F.). In mid-winter the temperature in the extreme northwestern section of the state sometimes falls to −23.3° C. (10° F. below zero.)

Massachusetts has 24 spring localities, with a total of 31 individual springs, 7 of which have been analyzed and 2 utilized as resorts.

The oldest works on mineral waters credit Massachusetts with but few mineral spring localities. Walton mentions 4, Crook's list about 10 and Peale 2. The springs are but slightly mineralized. Most of the mineral waters contain a small quantity of iron and are alkaline in character. Many of the springs have a local reputation and a few are used commercially. The list given herewith has been collected from personal investigation and from correspondence with physicians and spring owners. While the list is not complete, I feel that it is fairly representative of the active springs in use today.

## Ballard Vale Springs.

(*Middlesex County.*)

*Postoffice*, Andover. *Location*, in northeastern Massachusetts; north of Boston, the capital city, 22 miles; south of Lawrence, 10 miles; southwest of Nashua, N. H., 20 miles. *Situation*, in a barren rocky region, nestling on the side of a high hill, in the beautiful valley of the Shawsheen River, overlooking the Shawsheen Valley. *Access*, via the New York, New Haven & Hartford Railway System. *Hotel*, there are good accommodations at Andover. The springs issue from a rocky deposit which is supposed to contain lithia-bearing minerals, such as spodumene and lipidolite. The analysis below shows the mineralization:

BALLARD VALE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Dept. Agr., Bull. No. 139). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 0.49 |
| Sodium chloride (NaCl) | 3.82 |
| Sodium sulphate ($Na_2SO_4$) | 1.92 |
| Sodium nitrate ($NaNO_3$) | 0.5 |
| Sodium bicarbonate ($NaHCO_3$) | 0.25 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2.88 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 4.54 |
| Ferric oxide ($Fe_2O_3$) | 0.10 |
| Silica ($SiO_2$) | 7.30 |
| Total solids | 21.35 |
| Temperature, °C. | 4.4 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 1.7 |
| Carbon dioxide set free on evaporation, cc. per liter | 0.9 |

The analysis shows this to be a slightly mineralized, calcic and magnesic, bicarbonated and sodic, muriated, alkaline-saline water. Approximately 36 per cent of the salts in solution are in the form of the bicarbonates of calcium, magnesium and sodium, and 18 per cent of sodium chloride and 9 per cent of sodium sulphate. This water possesses diuretic and slight antacid properties. It is bottled and shipped extensively.

## Goulding Spring.

(*Plymouth County.*)

*Postoffice,* Whitman. *Location,* in eastern Massachusetts; south of Boston, the capital city, 23 miles; west of Cape Cod, 35 miles; east of Southbridge, 50 miles; northeast of Fall River, 30 miles. *Situation,* in the western edge of the tide water section, in an undulating region about 400 feet above sea level. *Access,* via the New York, New Haven & Hartford Railway System, or by motor over the splendid macadam highways which traverse this section. *Hotel,* no accommodations at the springs, but there is a good hotel at Whitman, only 1 mile distant. The following analysis shows the mineralization:

GOULDING SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Dept. Agr., Bull. No. 139). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 2.65 |
| Sodium chloride (NaCl) | 11.90 |
| Magnesium chloride ($MgCl_2$) | 5.20 |
| Magnesium sulphate ($MgSO_4$) | 5.40 |
| Sodium nitrate ($NaNO_3$) | 15.10 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 4.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 23.40 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.10 |
| Silica ($SiO_2$) | 19.90 |
| Total solids | 88.85 |
| Temperature, °C. | 10 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 4.2 |
| Carbon dioxide evaporated to dryness, cc. per liter | 3.9 |

The analysis shows this to be a very lightly mineralized, sodic, calcic, bicarbonated, muriated, nitrated, alkaline-saline water, possessing diuretic and antacid properties. Approximately 31 per cent of the salts in solution are in the form of the bicarbonates of calcium and magnesium, 17 per cent of sodium nitrate and 13 per cent of sodium chloride. This is a very pure wholesome water, which is bottled and shipped extensively.

## Nobscott Mountain Spring.

(*Middlesex County.*)

*Postoffice,* Framingham. *Location,* in eastern Massachusetts; west of Boston, the capital city, 23 miles; north of Providence, R. I., 40 miles; east of Worcester, 23 miles. *Situation,* at the base of Nobscott Mountain, the highest point in Middlesex County, at an elevation of

750 feet above tide water. *Access,* via the Southern Division of the Maine Central Railway, or by motor over the splendid highways which traverse this section. *Hotel,* good accommodations at Framingham; none at the springs. The springs issue from a solid ledge of rock, and the surrounding water shed is a heavily wooded glacial moraine, free from human habitation, which insures against any possible contamination. The analysis below shows the mineralization:

NOBSCOTT MOUNTAIN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Dept. Agr., Bull. No. 139). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 2.30 |
| Sodium chloride (NaCl) | 2.80 |
| Sodium sulphate ($Na_2SO_4$) | 5.20 |
| Sodium nitrate ($NaNO_3$) | 0.75 |
| Sodium nitrite ($NaNO_2$) | faint trace |
| Sodium bicarbonate ($NaHCO_3$) | 5.10 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 6.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 16.60 |
| Ferric oxide ($Fe_2O_3$) | 1.70 |
| Calcium silicate ($CaSiO_3$) | 3.80 |
| Silica ($SiO_2$) | 8.70 |
| Total solids | 52.95 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 8.4 |
| Carbon dioxide set free on evaporation | 3.9 |
| Flow in gallons per day | 24,000 |

The analysis shows this to be a slightly mineralized, calcic, magnesic and sodic, bicarbonated, alkaline water. Approximately 52 per cent of the salts in solution are in the form of the bicarbonates of calcium, magnesium and sodium, with 10 per cent of sodium sulphate and 5 per cent of sodium chloride. This water possesses diuretic and slight antacid properties. The waters are bottled and shipped extensively.

## Sand Spring.

### (*Berkshire County.*)

*Postoffice,* Williamstown. *Location,* in the northwestern corner of the state; north of Pittsfield, 20 miles; west of North Adams, 7 miles; south of Bennington, Vt., 11 miles. *Situation,* in the eastern foothills of the Taconic Range of mountains, lying in the beautiful valley of the Hoosic River, at an elevation of 1100 feet above sea level. *Access,* via the New York Central Railways System and connections, or by motor over the splendid state highways. *Hotels,* good accommodations at Williamstown. The analysis on page 422 shows the mineralization of this spring:

SAND SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 3.43 |
| Sodium chloride (NaCl) | 2.69 |
| Sodium sulphate ($Na_2SO_4$) | 12.12 |
| Sodium nitrate ($NaNO_3$) | 0.91 |
| Magnesium sulphate ($MgSO_4$) | 1.89 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 46.99 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 97.77 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 7.64 |
| Silica ($SiO_2$) | 21.70 |
| Total solids | 195.14 |
| Temperature, °C. | 24.4 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 0.8 |
| Carbon dioxide set free on evaporation, cc. per liter | 21.6 |
| Flow in gallons per day | 57,600 |

The analysis shows this to be a lightly mineralized, calcic, magnesic, bicarbonated alkaline water, possessing diuretic, antacid and slight tonic properties. Approximately 78 per cent of the salts in solution are in the form of the bicarbonates of calcium and magnesium, with small amounts of the chlorides of sodium and potassium. This water should be of use in the treatment of gastric disturbances due to acidity and hyperacidity and in the milder forms of irritation of the genito-urinary tract, where an alkaline water is indicated. The waters are bottled and shipped extensively.

## Simpson Springs.

(*Bristol County.*)

*Postoffice*, South Easton. *Location*, in southern Massachusetts; southwest of Boston, the capital city, 30 miles; north of Fall River, 30 miles. *Situation*, in an undulating region of country, at an elevation of 300 feet above tide water. *Access*, via the New York, New Haven & Hartford Railway System. *Hotel*, no hotels in the town and none at the springs, the water being used largely to manufacture light beverages, and it is also bottled and shipped commercially. The analysis below shows the mineralization:

The analysis shows this to be a slightly mineralized, sodic, calcic, bicarbonated, muriated, sulphated, alkaline-saline water, possessing diuretic and antacid properties. Approximately 43 per cent of the salts in solution are in the form of the bicarbonates of sodium sulphate, making a delightful table water.

SIMPSON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 2.10 |
| Sodium chloride (NaCl) | 8.60 |
| Sodium sulphate ($Na_2SO_4$) | 7.10 |
| Sodium nitrate ($NaNO_3$) | 3.01 |
| Sodium bicarbonate ($NaHCO_3$) | 0.70 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 5.40 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 13.30 |
| Calcium silicate ($CaSiO_3$) | 2.60 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.20 |
| Silica ($SiO_2$) | 1.00 |
| Total solids | 45.01 |
| Carbon dioxide, free, cc. per liter | 8.4 |
| Carbon dioxide set free on evaporation, cc. per liter | 2.7 |

The following springs were once used as resorts:

*Allandale Springs, P. O.*, West Roxbury, Suffolk County. There are 2 springs in this area, but no definite information or satisfactory analysis available.

*Berkshire Soda Springs, P. O.*, Great Barrington, Berkshire County. This was once a very popular resort, and the famous Berkshire Inn offered accommodations. The place was equipped for hot and cold bathing. No definite information nor satisfactory analysis available.

*Columbia Lithia Spring, P. O.*, Revere, Suffolk County. The location is about 1 mile from Crescent Beach, now a part of the State Park Reservation. The elevation is about 300 feet above sea level. The waters have been extensively exploited as a potable water. No definite information nor satisfactory analysis available. Postmaster writes across correspondence "establishment abandoned."

*Commonwealth Mineral Springs, P. O.*, Waltham, Middlesex County. Once a resort of local prominence. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Dearborn Mineral Springs, P. O.*, East Dedham. No definite information nor satisfactory analysis available.

*Massasoit Spring, P. O.*, Springfield, Hampden County. Once a resort, largely patronized by visitors from surrounding counties. No definite information or satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Purity Springs, P. O.*, Danvers, Essex County. No definite information or satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Abbott Spring, P. O.*, Methuen, Essex County.

*Blue Hill Spring, P. O.*, Milton, Norfolk County.

*Burnham Spring, P. O.*, Methuen, Essex County.

*Cascella Spring, P. O.*, Three Rivers, Hampden County.

*Chapman's Crystal Spring, P. O.*, Stoneham, Middlesex County.
*Chelmsford Spring, P. O.*, Chelmsford, Middlesex County.
*Crystal Spring, P. O.*, West Peabody, Essex County.
*El-Azhar Spring, P. O.*, Tyngsboro, Middlesex County.
*Emmons Spring, P. O.*, Lawrence, Essex County.
*Hamilton Mineral Spring, P. O.*, Framingham, Middlesex County.
*King Philip Spring, P. O.*, Mattapoisett, Plymouth County.
*Klines Spring*, Lawrence, Essex County.
*Leicester Polar Springs, P. O.*, Leicester, Worcester County.
*Monatiquot Spring, P. O.*, South Braintree, Norfolk County.
*Mount Blue Mineral Spring, P. O.*, Hingham, Plymouth County.
*Mount Holyoke Spring, P. O.*, South Hadley, Hampshire County.
*Mount Pleasant Spring, P. O.*, Lowell, Middlesex County.
*Nemasket Mineral Spring, P. O.*, Middleboro, Plymouth County.
*Norwood Spring, P. O.*, Norwood, Norfolk County.
*October Spring, P. O.*, Lenox, Berkshire County.
*Old Homestead Springs, P. O.*, Lawrence, Essex County.
*Peerless Spring, P. O.*, Lynn, Essex County.
*Pepperell Spring, P. O.*, Pepperell, Middlesex County.
*Pilgrim Springs, P. O.*, Marshfield, Plymouth County.
*Pocahontas Spring, P. O.*, Lynfield, Essex County.
*Powato Well, P. O.*, Wareham, Plymouth County.
*Purity Spring, P. O.*, Lowell, Middlesex County.
*Robbins Spring, P. O.*, Arlington, Middlesex County.
*Shawmut Spring, P. O.*, Quincy, Norfolk County.
*Sterling Spring, P. O.*, Lynn, Essex County.

## MICHIGAN.

Michigan extends from 41°30′ to 47°31′ north latitude and from 84°24′ to 90°33′ west longitude, and comprises an area of 58,915 square miles, of which 1985 square miles are water. It is divided by the Great Lakes into two irregular peninsulas, known as the Upper and Lower Peninsulas. The upper, or northern portion, is rugged, and in some parts mountainous, while the southern peninsula is an undulating plain of unbroken savannas. The Great Lakes on her border give Michigan a coast line of 1624 miles. There are a number of small lakes. The lake and river scenery is celebrated for its sylvian beauty and attractiveness. The climate is mild, but the temperature varies considerably. The annual mean temperature, as observed at Mackinac, is 5° C. (41.02° F.), the winter temperature for Detroit being −28.9° C. (20° F. below zero). Michigan lies in the heart of the North Temperate Zone and the northern peninsula has a very rigorous climate.

Michigan has 44 spring localities, with a total of 76 individual springs, 28 of which have been analyzed and a few used as resorts. The mineral waters of this state are derived principally from wells

which are nevertheless termed mineral springs. Many of the wells are artesian, and were sunk originally for other purposes than mineral waters. The borings, especially in the corniferous limestones and huron group (Devonian) contain all their original soluble constituents; hence all artesian waters in the state, save the outlying leached-out places of the Parma sandstone, are mineralized. The waters are classed as saline, carbonated and sulphuretted. The saline and sulphuretted springs predominate. Some of the Michigan mineral waters were long supposed to possess "magnetic" properties, and are still, in some instances, referred to in this connection. In the list given herewith the author has drawn on Peale's list, Walton's work and Crook's book, and much of the information recorded was obtained from correspondence with physicians and from spring owners. While the list is not 100 per cent perfect it is nevertheless fairly correct as to the active springs at the present day.

### Alpena Magnetic Sulphur Spring.

(*Alpena County.*)

*Postoffice,* Alpena. *Location,* in northeastern Michigan; north of Lansing, the capital city, 180 miles; north of Saginaw, 125 miles. *Situation,* on Thunder Bay, overlooking Lake Huron, at an altitude of about 600 feet above sea level. *Access,* via lake steamers and the New York Central Railway lines and connections. *Hotel,* there are good hotel accommodations in Alpena. The bathing establishment is modern in construction and equipment and commodious and sumptious in point of elegance, comfort and appointments. The spring (well) was accidently discovered in 1869 while boring for a salt vein; when a depth of 900 feet was reached an immense volume of water gushed forth with such force as to suspend operations. The strong odor of sulphur was so pronounced that the well was abandoned, and in 1891 another well was sunk to the depth of 1052 feet, which pierced a stratum of loadstone which so completely magnetized the drill that it was with difficulty removed from the iron casing. The water on analysis reveals the following mineralization:

ALPENA MAGNETIC SULPHUR SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, S. P. Duffield). |
|---|---|
| Sodium chloride ($NaCl$) | 1167.07 |
| Calcium sulphate ($CaSO_4$) | 514.02 |
| Sodium bicarbonate ($NaHCO_3$) | 273.15 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1075.91 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 962.89 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 31.46 |
| Aluminum oxide ($Al_2O_3$) | 18.21 |
| Silica ($SiO_2$) | 34.62 |
| Total solids | 4077.33 |
| Gases: | |
| Carbon dioxide, cc. per liter | 29 |
| Hydrogen sulphide, cc. per liter | 123 |

Medicinal classification, alkaline b, weak saline 3 or (Ab, −Cl 3), sulphuretted. This is a moderately highly mineralized, sodic, bicarbonated and muriated saline water, sulphuretted, possessing diuretic, antacid, slight tonic and alterative properties. The waters have been used with gratifying results in chronic rheumatism, acid dyspepsia, neurasthenia, vesical catarrh and renal irritation, etc. The baths are efficacious in skin affections of a chronic nature.

## Eastman Springs.

### (*Berrien County.*)

*Postoffice*, Benton Harbor. *Location*, in southwest Michigan; southwest of Lansing, the capital city, 110 miles; southwest of Grand Rapids, 75 miles. *Situation*, on St. Joseph's River, in the Michigan fruit belt, at an elevation of about 650 feet above sea level. *Access*, via the New York Central Railway System. *Hotel*, there is a small resort hostelry with fair accommodations and conveniences. There are some 19 springs in this area, of which the analysis of the more important ones are given herewith:

EASTMAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | |
|---|---|---|---|---|---|
| | Analyst, W. S. Haines. | | Analyst, H. G. Harrison. | | Analyst, E. G. Smith. |
| | King David Spring. | Silver Queen Spring. | Silver King Spring. | Bimini Spring. | Golden Fountain Spring. |
| Sodium chloride ($NaCl$) | 1.88 | 1.53 | 1.71 | 1.71 | 1.53 |
| Potassium sulphate ($K_2SO_4$) | 2.39 | trace | trace | 0.85 | 1.88 |
| Sodium sulphate ($Na_2SO_4$) | ... | ... | ... | 8.89 | 4.44 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | ... | ... | 3.07 |
| Sodium phosphate ($Na_2HPO_4$) | ... | ... | ... | 0.17 | 0.68 |
| Magnesium phosphate ($Mg_3[PO_4]_2$) | trace | ... | 0.17 | trace | |
| Lithium bicarbonate ($LiHCO_3$) | ... | ... | 51.81 | | |
| Potassium bicarbonate ($KHCO_3$) | ... | 18.29 | 17.95 | | |
| Sodium bicarbonate ($NaHCO_3$) | 11.45 | 23.25 | 19.32 | 4.44 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 60.36 | 55.06 | 53.35 | 60.70 | 54.89 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 138.85 | 116.28 | 85.84 | 127.90 | 140.22 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | ... | ... | ... | ... | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 22.10 | ... | ... | 1.19 | 6.49 |
| Aluminum oxide ($Al_2O_3$) | 1.88 | ... | ... | 0.51 | 0.17 |
| Silica ($SiO_2$) | 9.91 | 1.88 | 1.88 | 9.23 | 6.84 |
| Total solids | 248.82 | 216.29 | 232.23 | 215.59 | 220.21 |
| Gases: | | | | | |
| Carbon dioxide, cc. per liter | 139.4 | 122.3 | 168 | Not. es. | Not. es. |

A careful survey of the analysis of the Eastman Springs shows that the percentage of the predominating chemical constituents of the different springs are so similar that they may be classed as slightly mineralized, calcic, magnesic, sodic, bicarbonated alkaline (ferruginous) water, carbon-dioxated, possessing diuretic, antacid and slight tonic properties. This is a remarkable group of springs. They are all more or less carbonated, some heavily charged with carbonic-acid gas, and the Silver King Spring carries, in addition to the other chemical constituents, lithium bicarbonate, 51 mg. per liter, which gives this spring additional therapeutic properties. These waters are useful in the treatment of gastric affections due to acidity or hyperacidity and in disorders of the genito-urinary system; in the latter the Silver King Spring is especially suitable.

## Clark's Red Cross Mineral Well.

(*Macosta County.*)

*Postoffice*, Big Rapids. *Location*, in central Michigan; northwest of Lansing, the capital city, 84 miles; north of Grand Rapids, 65 miles. *Situation*, in the southern outskirts of the town of Big Rapids, at an elevation of about 600 feet above sea level. *Access*, via the New York Central lines and connections. *Hotel*, a good hotel is just across the street from the bath house, which is modern in its appointments. The water on analysis reveals the following mineralization.

CLARK'S RED CROSS MINERAL WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, A. B. Prescott). |
|---|---|
| Sodium chloride (NaCl) | 223,130.88 |
| Magnesium chloride ($MgCl_2$) | 23,782.33 |
| Calcium chloride ($CaCl_2$) | 55,766.17 |
| Sodium bromide (NaBr) | 1,486.84 |
| Potassium iodide (KI) | trace |
| Calcium sulphate ($CaSO_4$) | 568.40 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 123.55 |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silicic acid ($H_2SiO_3$) | 1.19 |
| Total solids | 304,879.36 |

Medicinal classification, very strong saline 6 or (++Cl 6). The analysis shows this to be a very highly mineralized, sodic, calcic, magnesic, muriated, saline (ferruginous) water. This is one of the most heavily mineralized waters known, the St. Clair Spring in this state being slightly higher. The water is too strong for internal use, unless largely diluted, from 1 to 2 tablespoonfuls in a large glass of water usually sufficing for normal dosage. If taken in stronger concentration vomiting and purging are said to follow. The water is recommended in numerous internal disorders and for its local effects in the form of baths, etc. For cuts, burns, bruises, its local applica-

tion is said to be curative. The hot-brine baths are efficacious in relieving chronic rheumatic disturbances, such as chronic articular joint disorders.

## Eaton Rapids Wells.

*(Eaton County.)*

*Postoffice*, Eaton Rapids. *Location*, in southern Michigan; south of Lansing, the capital city, 20 miles; southeast of Charlotte, the county seat, 10 miles. *Situation*, in the Grand River Valley, at an elevation of about 675 feet above sea level. *Access*, via the Grand River Valley Railway to Eaton Rapids. *Hotel*, there are numerous hotels, with modern conveniences. Several of the hotels maintain bathing establishments, with all facilities for the application of the science of hydrotherapy and balneotherapy. The analysis of the waters of the different wells below shows the mineralization:

EATON RAPIDS WELLS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analyst, R. C. Kedzie. | | | Analyst, C. T. Jackson. |
| | Bodine Spring. | Mosher Spring. | Shaw Spring. | Sterling Spring. |
| Sodium chloride ($NaCl$) | 25.65 | 15.39 | 15.39 | 89.09 |
| Sodium sulphate ($Na_2SO_4$) | ... | ... | ... | 215.28 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | ... | 160.74 |
| Calcium sulphate ($CaSO_4$) | 983.25 | 772.23 | 823.02 | 943.92 |
| Potassium bicarbonate ($KHCO_3$) | 51.30 | 31.85 | 35.18 | |
| Sodium bicarbonate ($NaHCO_3$) | 86.15 | 149.03 | 320.52 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 143.64 | 125.22 | 94.37 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 692.03 | 538.24 | 564.43 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 38.47 | 17.10 | 38.13 | 61.36 |
| Silica ($SiO_2$) | 34.10 | 43.43 | 23.94 | |
| Total solids | 1854.59 | 1692.49 | 1614.98 | 1470.39 |
| Gases: | | | | |
| Carbon dioxide, cc. per liter | 59.8 | 52.3 | 43.9 | |

Bodine Spring, Mosher Spring and Shaw Spring, medicinal classification, weak alkaline b2, weak calcic sulphated 2 or (−Ab2, −CaS2). The analyses of the Bodine, Mosher and Shaw Springs reveal such a close similarity in the percentage of their chemical constituents and in the amount of total solids that we may classify them as moderately highly, mineralized, calcic, sulphated, bicarbonated, alkaline (ferruginous) water, slightly carbon-dioxated, possessing diuretic and marked antacid and tonic properties, and should be efficacious in gastric disorders due to acidity and hyperacidity; owing to the high percentage

of calcium sulphate, these waters should exert decided diuretic action and allay irritation of the genito-urinary tract.

Sterling Spring, medicinal classification, weak calcic sulphated 3, very weak ferruginous 0.8 (−CaS3, − −Fe 0.8). This is a moderately highly mineralized, calcic, magnesic, sodic, sulphated saline (ferruginous) water, possessing diuretic, laxative and tonic properties, and should be useful in the treatment of catarrhal conditions of the alimentary tract, constipation and in sluggish hepatic function and in anemia and run-down conditions and general debility.

## Magnetic Mineral Spring.

*(Gratiot County.)*

*Postoffice*, St. Louis. *Location*, near the center of the state; east of Saginaw, 32 miles; northeast of Grand Rapids, 85 miles. *Situation*, on the banks of the Pine River, near the northern boundary of the county, at an elevation of 725 feet above sea level, in the finest agricultural section of the state. *Access*, via St. Louis on the Pierre Marquette Railway (Grand Rapids & Saginaw Division and Trunk Roads M–14 and M–46), thence a distance of only 6 city blocks to the springs and hotel. *Hotel*, there is a modern four-story brick structure, with modern conveniences; hot and cold running magnetic mineral water in every room. The bathing establishment is modern in construction and equipment, where the latest knowledge of the science of hydrology is applied for the relief of human ailments. The sanitarium and hospital department is a model of perfection in its scientific appointments and administration, which, with the bathing establishments, is under the personal supervision of a competent medical director and a corps of trained assistants and trained nurses, when needed. This resort has been continuously operated for the past forty years. Summer resort is open for guests during the summer and fall and the hotel, sanitarium and bathing establishment throughout the year. The spring (well) on the bank of Pine River, 207 feet in depth, with a head of 16 feet of water above the river, has a flow of 200 gallons per minute. The following analysis shows the mineralization:

MAGNETIC MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, A. J. Patten). |
|---|---|
| Sodium chloride (NaCl) | 40.90 |
| Magnesium sulphate ($MgSO_4$) | 151.50 |
| Calcium sulphate ($CaSO_4$) | 224.90 |
| Sodium bicarbonate ($NaHCO_3$) | 113.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 161.62 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 5.68 |
| Silica ($SiO_2$) | 11.80 |
| Total solids | 709.55 |
| Temperature, °C. | 10 |
| Flow in gallons per day | 228,000 |

Medicinal classification, weak calcic sulphated or (−CaS). The analysis shows a moderately mineralized, calcic, sulphated and bicarbonated alkaline (ferruginous) water, possessing diuretic, antacid and tonic properties. The waters are endorsed by the profession and used with success in the treatment of rheumatism and chronic skin affections, sciatica, neuritis and neurasthenia; it is also of value in the alleviation of irritable conditions of the genito-urinary tract and in catarrhal disorders of the intestinal tract. The water as it comes from the well is sparkling with carbonic-acid gas. It is a pleasing, refreshing, drinkable water. The hotel and sanitarium have been recently renovated and refitted and refurnished, with every modern appliance and appointment for the scientific handling of medical and surgical cases. A competent corps of eminent physicians and surgeons and trained nurses are in attendance.

## Mount Clemens Mineral Springs.

*(Macomb County.)*

*Postoffice,* Mt. Clemens. *Location,* in southeastern Michigan; east of Lansing, the capital city, 80 miles; southwest of Port Huron, 35 miles; northeast of Detroit, 22 miles; north of Leamington, Canada, 40 miles. *Situation,* on Lake St. Clair, this beautiful resort city is surrounded by a beautiful rolling country, and has all the conveniences of larger cities. *Access,* via the Grand Trunk Railways and via the Detroit Interurban Railway and also via motor over the splendid national highways. *Hotel,* this is a resort city, with several good hotels. The bathing establishments are modern in construction and equipment; every feature of hydrotherapy and balneotherapy is available. The latest knowledge in the art of hydriatics is under the direction of competent hydrologists. The Mt. Clemens Springs waters on analysis reveals the following mineralization.

MOUNT CLEMENS MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Lithium chloride ($LiCl$) | 105.9 |
| Potassium chloride ($KCl$) | 1,707.1 |
| Sodium chloride ($NaCl$) | 76,108.8 |
| Magnesium chloride ($MgCl_2$) | 14,948.8 |
| Calcium chloride ($CaCl_2$) | 34,039.9 |
| Potassium bromide ($KBr$) | 725.0 |
| Potassium iodide ($KI$) | 3.0 |
| Calcium sulphate ($CaSO_4$) | 777.6 |
| Sodium metaborate ($NaBO_2$) | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 4.2 |
| Silica ($SiO_2$) | 11.0 |
| Total solids | 128,648.8 |
| Gases: | |
| Hydrogen sulphide, cc. per liter | 14.3 |

Medicinal classification, very strong saline 2.6 or (++Cl 2.6), sulphuretted. The analysis shows this to be a very highly mineralized, sodic, calcic, magnesic, muriated saline (lithic, bromic, iodic) water, sulphuretted, possessing diuretic, laxative, tonic and alterative properties. The waters quite closely resemble those of Achel-Maunstein in Bavaria; it is necessary, owing to the excessive mineralization, to dilute the water for internal use and for bathing. The use of these waters for bathing and drinking cures have acquired considerable reputation in the treatment of scrofulous disorders of the skin, bones and joints, rheumatism, chronic articular joint diseases, sciatica, neuritis, gout and the uric-acid diathesis, neurasthenia and general nervous breakdowns, kidney and bladder affections, constipation, etc.

## Mount Clemens Victory Spring.

(*McComb County.*)

*Postoffice*, 23 E. Third St., Mt. Clemens. *Location*, in eastern Michigan; northwest of Detroit, 20 miles; east of Grand Rapids, 180 miles. *Situation*, on the western shore of Lake St. Clair, whose eastern shore is in the Dominion of Canada. *Access*, via the Chicago & Alton Railway System, thence a distance of 1 mile to the springs. *Hotel*, the hotel is a commodious resort hostelry, with modern conveniences. The waters on analysis reveal the following mineralization:

MOUNT CLEMENS VICTORY SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. O. Schotterbeck). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 14.20 |
| Sodium chloride (NaCl) | 36.10 |
| Potassium sulphate ($K_2SO_4$) | 2.05 |
| Sodium sulphate ($Na_2SO_4$) | 13.00 |
| Calcium sulphate ($CaSO_4$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 116.97 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 363.66 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | trace |
| Silica ($SiO_2$) | 10.95 |
| Total solids | 565.93 |

Medicinal classification, weak alkaline b or (−Ab). The analysis shows a moderately mineralized, calcic and magnesic, bicarbonated alkaline water, possessing antacid, diuretic and slight alterative properties. The waters have the endorsement of the profession in the treatment of digestive disturbances due to acidity; it exerts a soothing effect in irritable conditions of the renal and vesical organs. The sulphate and chlorine radicles exert eliminative action. The water is clear, sparkling, pure and palatable.

## Moorman's Mineral Well.

*(Washtenaw County.)*

*Postoffice*, Ypsilanti. *Location*, in southeastern Michigan; west of Detroit, 38 miles; east of Kalamazoo, 95 miles; south of Saginaw, 80 miles. *Situation*, in the charming little city of Ypsilanti, at an elevation of 650 feet above sea level, surrounded by all the conveniences of a modern city. *Access*, via the Michigan Central & Lake Shore and the Lake Shore & Michigan Southern Railways. *Hotel*, there are ample accommodations with modern conveniences. The Ypsilanti bath-house is a very large, ornate bathing establishment, comprising some 40 large bath-rooms, with all the appointments of a high-class bathing establishment. The water is supplied direct from this well, which has the following mineralization:

MOORMAN'S MINERAL WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. H. Shappard). |
|---|---|
| Sodium chloride ($NaCl$) | 26,908.90 |
| Magnesium chloride ($MgCl_2$) | 2,207.26 |
| Calcium chloride ($CaCl_2$) | 2,451.28 |
| Magnesium bromide ($MgBr_2$) | 187.58 |
| Potassium sulphate ($K_2SO_4$) | 605.14 |
| Magnesium sulphate ($MgSO_4$) | 1,774.29 |
| Calcium sulphate ($CaSO_4$) | 3,003.61 |
| Sodium phosphate ($Na_3PO_4$) | trace |
| Sodium borate ($Na_2B_4O_7$) | trace |
| Lithium bicarbonate ($LiHCO_3$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1,486.28 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | trace |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Sodium sulphide ($NaS$) | 144.08 |
| Silica ($SiO_2$) | 337.75 |
| Total solids | 29,106.37 |
| Gases: | |
| Hydrogen sulphide, cc. per liter | 92.5 |

Medicinal classification, strong saline 3, calcic sulphated 2 or (+Cl 3, CaS2), sulphuretted. This is a highly mineralized, sodic, magnesic, calcic, muriated, sulphated bicarbonated, saline (bromic) water, sulphuretted, possessing diuretic, purgative and alterative properties. The hot-brine baths are valuable adjuvants in the treatment of chronic rheumatic disturbances, etc.

## St. Clair Springs.

*(St. Clair County.)*

*Postoffice*, St. Clair. *Location*, in eastern Michigan; east of Lansing, the capital city, 100 miles; south of Port Huron, 10 miles; northeast

of Mount Clemens, 30 miles. *Situation*, on the bank of the St. Clair River in the southern outskirts of the city of St. Clair, surrounded by all the advantages and luxuries to be found at the older American or European spas. *Access*, via the Grand Trunk Railway. *Hotel*, the hostelry is a modern resort, with ample conveniences. The bathing establishment is modern in construction and equipment, ornate interior, elaborate in detail, luxurious in appointments; it is under the supervision of a competent hydrologist, and all the latest in the science of hydrotherapy and balneotherapy are available here. The springs on analysis reveal the following mineralization:

ST. CLAIR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, Professor Duffield.) St. Clair Spring. | (Analyst, C. F. Chandler.) Salutaris Spring. |
|---|---|---|
| Potassium chloride (KCl) | ... | 28.89 |
| Sodium chloride (NaCl) | 138,852.00 | 1390.74 |
| Mganesium chloride ($MgCl_2$) | 17,308.62 | |
| Calcium chloride ($CaCl_2$) | 126,235.62 | |
| Potassium sulphate ($K_2SO_4$) | ... | trace |
| Calcium sulphate ($CaSO_4$) | 2,465.82 | |
| Magnesium iodide ($MgI_2$) | trace | |
| Magnesium bromide ($MgBr_2$) | trace | |
| Sodium bicarbonate ($NaHCO_3$) | ... | 143.23 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | trace | 107.48 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | ... | 142.11 |
| Ammonium bicarbonate ($NH_4HCO_3$) | ... | trace |
| Aluminum oxide ($Al_2O_3$) | 14,193.000 | |
| Silica ($SiO_2$) | 7,113.60 | 9.74 |
| Total solids | 305,168.66 | 1822.19 |
| Gases: | | |
| Hydrogen sulphide, cc. per liter | 88.6 | |
| Carbon dioxide, cc. per liter | ... | 1602.3 |

St. Clair Spring, medicinal classification, very strong saline 6, strong aluminic 2 or (++Cl 6, +Al 2), sulphuretted. This is a very highly mineralized, sodic, calcic, magnesic, muriated, saline (aluminic) water, sulphuretted. This water is too highly mineralized for internal use, unless diluted, usually from 1 to 2 tablespoonfuls, four times daily, in a large glass of plain water. If taken in too concentrated solution vomiting and purging will follow, but finds a useful field in the application of brine baths. This is one of the most heavily mineralized waters in the world.

Salutaris Spring, medicinal classification, weak alkaline ab, weak saline 4 or (−Aab, −Cl 4), carbon-dioxated. This is a moderately highly mineralized, sodic, muriated and bicarbonated alkaline-saline water, carbon-dioxated, possessing diuretic and antacid properties. It has been found efficacious in acid dyspepsia and feeble digestion, and some physicians claim it of decided benefit in the treatment of albuminuria.

The following springs were once used as resorts:

*Alma Magnetic Mineral Wells, P. O.*, Alma, Gratiot County. There are 3 springs, or wells, a sanitarium and hotel. No definite information nor satisfactory analysis available.

*Americanus Mineral Well, P. O.*, Lansing, Ingraham County. This was formerly known as the Michigan Congress Well. No definite information or satisfactory analysis available.

*Butterworth's Mineral Springs, P. O.*, Grand Rapids, Kent County. Situated on Huron Street, in the city of Grand Rapids. Accommodations and bathing establishment. No definite information or satisfactory analysis available. Correspondence returned marked "unknown."

*Fruit Port Well, P. O.*, Fruit Port, Muskegon County. Once a resort, popular with the citizens of Chicago. Correspondence marked "unknown." No definite information or satisfactory analysis available.

*Grand Haven Mineral Wells, P. O.*, Grand Haven, Ottawa County. Situated on Lake Michigan. Once popular as a resort. Correspondence returned marked "unknown." No definite information nor satisfactory analysis available.

*Owosso Spring, P. O.*, Owosso, Shiawassee County. Situated northwest of Detroit. Correspondence returned marked "unknown." No definite information nor satisfactory analysis available.

*Plymouth Rock Mineral Well, P. O.*, Plymouth, Wayne County. No definite information nor satisfactory analysis available.

*Spring Lake Well, P. O.*, Spring Lake, Ottawa County. Once a local resort of some prominence. Correspondence returned marked "unknown. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Andrew's Magnetic Mineral Springs, P. O.*, St. Louis, Gratiot County.
*Artic Spring, P. O.*, Grand Rapids, Kent County.
*John Gerick Farm Spring, P. O.*, Denton, Wayne County.
*Maple Leaf Spring, P. O.*, Mount Clemens, Macomb County.
*Panacea Spring, P. O.*, Mount Clemens, Macomb County.
*Ponce de Leon Spring, P. O.*, Grand Rapids, Kent County.
*Silver Spring, P. O.*, Northville, Wayne County.

## MINNESOTA.

Minnesota extends from 43°30′ to 49° north latitude and from 89°29′ to 97°5′ west longitude, and comprises an area of 83,365 square miles, of which 4160 square miles are water. The state has an extreme length from north to south of about 400 miles, and from east to west of about 380 miles. The state contains the crest of the great low plain on North America and occupies nearly the center of the continent. The surface of the state may be said to be an undulating plain, with

an average elevation of 1000 feet above sea level, but in the northeast there is a group of low sand hills which rise to the height of 1600 feet above sea level. The lowest portion of the state is the region around the head of Lake Superior, where the land falls to an elevation of 600 feet. The most important feature of Minnesota is the extinct Lake Agassiz. An incident in the recession of the pleocistine ice was the sinking of the marginal drainage of the ice sheet in the valley of the Red River as fast as it was uncovered by the melting ice. A great lake was formed, which has been called Lake Agassiz. At its largest stage it had a maximum width of nearly 700 miles, and drained through the Minnesota River into the Gulf of Mexico. On the disappearance of the ice, and the draining out of Lake Agassiz by the Nelson River, its bed was left as a level alluvial plain. The climate is invigorating, the summers cool and pleasant and the winters long and rigid, although severe, are tempered by the clearness and dryness of the atmosphere. The average temperature for January is −9° C. (15° F.); for July, 21.1° C. (70° F.). In some sections the midwinter temperature falls to −40° C. (40° F. below zero).

Minnesota has 27 spring localities, with 39 individual springs, 7 of which have been analyzed and 2 used as resorts. None of the older writers on mineral waters mention this state with having any mineral springs. Crook's work mentions 2 and Peale's list gives 2 localities. The list given herewith was secured through correspondence with physicians and spring owners.

### Conedale Springs.

(*Winona County.*)

*Postoffice*, Winona. *Location*, in the southeast corner of the state; north of Dubuque, Ia., 110 miles; northwest of LaCrosse, Wis., 20 miles. *Situation*, west of the Mississippi River and in the valley of the same. The terrain is typical of southeastern Minnesota, hill and dale surrounded by a beautiful rolling region. The scenery is pleasing and attractive; the elevation is 800 feet above sea level. *Access*, via Winona on the main line of the Chicago, Milwaukee & St. Paul Railway System, thence by motor 14 miles to the springs, over splendid highways and through a beautiful picturesque rolling country of wooded hills and fertile vales. *Hotel*, no accommodations for guests. The water on analysis revealed the following:

CONEDALE SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, University Wisconsin). |
|---|---|
| Sodium and potassium chlorides (NaCl and KCl) | 4.6 |
| Magnesium sulphate ($MgSo_4$) | 4.1 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 178.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 208.1 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | trace |
| Total solids | 390.8 |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, magnesic, calcic, bicarbonated alkaline water, possessing diuretic and slight antacid properties. It is an admirable potable table water. It is bottled and shipped extensively.

## Glenwood-Inglewood Springs.

(*Hennepin County.*)

*Postoffice,* Minneapolis. *Location,* in the eastern portion of the state; west of St. Paul, 10 miles; in the city of Minneapolis. *Situation,* near Glenwood Park in the Twin City to St. Paul. *Access,* via the Great Railway center of the twin cities, Minneapolis and St. Paul. *Hotel,* the company operating the springs do not maintain hotel accommodations, but in both the twin cities there are a number of modern hotels. The analyses of the springs below show the mineralization of the waters:

GLENWOOD-INGLEWOOD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). Glenwood-Inglewood Spring. | White Rock Spring. |
|---|---|---|
| Sodium chloride (NaCl) | 1.80 | 9.13 |
| Potassium chloride (KCl) | ... | 3.60 |
| Sodium sulphate ($Na_2SO_4$) | 10.46 | |
| Magnesium sulphate ($MgSO_4$) | ... | 56.26 |
| Sodium phosphate ($Na_2HPO_4$) | trace | trace |
| Sodium nitrate ($NaNO_3$) | ... | 10.21 |
| Sodium bicarbonate ($NaHCO_3$) | 7.14 | |
| Potassium bicarbonate ($KHCO_3$) | 5.06 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 139.80 | 160.07 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 282.31 | 320.28 |
| Lithium bicarbonate ($LiHCO_3$) | trace | 0.53 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.95 | |
| Ferric oxide ($Fe_2O_3$) | ... | 0.37 |
| Aluminum oxide ($Al_2O_3$) | 0.99 | 1.85 |
| Silica ($SiO_2$) | 27.51 | 21.47 |
| Total solids | 476.02 | 583.77 |

Glenwood-Inglewood Spring and White Rock Spring, medicinal classification, weak alkaline b or (−Ab). A cursory examination of the analyses of the two springs shows a great similarity in the waters. Glenwood-Inglewood Spring is a calcic, magnesic, bicarbonated, alkaline water, possessing antacid and diuretic properties. White Rock Spring is very similar in its predominating chemical constituents and therapeutic properties to the Glenwood-Inglewood Spring. The waters from both springs come from great depths, heavily charged with carbonic-acid gas; they are both most excellent table waters.

## Indian Medical Spring.

*(Sherburne County.)*

*Postoffice*, Elk River. *Location*, in eastern Minnesota; north of St. Paul, the capital city, 40 miles; south of Aitkin, 80 miles; north of Minneapolis, 34 miles. *Situation*, in the Mississippi River Valley, at an elevation of about 1000 feet above sea level. *Access*, via the Great Northern Railway and the Northern Pacific Railway, thence by motor 4 miles north to the springs. *Hotel*, no definite information available as to class of accommodations. The spring has an immense flow, and the analysis below shows the mineralizaztion. The water is bottled and cold commercially.

INDIAN MEDICAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. W. Drew). |
|---|---|
| Sodium chloride ($NaCl$) | 6.49 |
| Potassium sulphate ($K_2SO_4$) | 5.31 |
| Sodium sulphate ($Na_2SO_4$) | 6.84 |
| Sodium bicarbonate ($NaHCO_3$) | 19.49 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 34.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 104.99 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.53 |
| Aluminum oxide ($Al_2O_3$) | 0.51 |
| Silica ($SiO_2$) | 17.78 |
| Total solids | 197.14 |

Gases:
Carbon dioxide and hydrogen sulphide, heavily charged.

Medicinal classification, carbon-dioxated, sulphuretted. The analysis shows this to be a lightly mineralized, calcic, magnesic, sodic, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic antacid and slight tonic properties. The water is claimed to be efficacious in the treatment of gastric disorders due to acidity and helpful in chronic rheumatism and skin diseases.

The following springs were once used as resorts:

*Owatonna Mineral Springs, P. O.*, Owatonna, Steel County. There are 9 springs in this area of the alkaline-calcic class. No definite information nor satisfactory analysis available.

*White Mineral Springs, P. O.*, Minnesota City, Winona County. There are a number of springs in this locality, but no definite information or satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Blue Spruce Farm Spring, P. O.*, Hanley Falls, Yellow Medicine County.

*Clear Spring, P. O.*, Hopkins, Hennepin County.

*Deep Spring, P. O.*, Crookston, Polk County.

*Glen Springs, P. O.*, Excelsior, Hennepin County.
*Highland Spring, P. O.*, St. Paul, Ramsey County.
*Pokegama Springs, P. O.*, Detroit, Necker County.
*Red Star Spring, P. O.*, Cold Spring, Stearns County.
*Rock Spring, P. O.*, Shakopee, Scott County.
*Silver Springs, P. O.*, Marshall, Lyon County.
*Ward Spring, P. O.*, Ward Springs, Tood County.

## MISSISSIPPI.

Mississippi extends from 30°20′ to 35° north latitude and from 82°12′ to 91°40′ west longitude, and comprises an area of 46,340 square miles, of which 470 square miles are occupied by water. The state has an extreme length of 330 miles and an extreme width of 188 miles. The highest ridges in the northeast section of the state reach an elevation of 1000 feet; throughout the state the elevations range from 500 to 600 feet, and within a few miles of the Gulf of Mexico the elevations drop to 150 feet. The climate is warm, the winters being short and mild and the summers long and hot. The state is within the semitropical belt, and the climate is strongly influenced by the close proximity to the Gulf of Mexico. The average January temperature is 13° C. (55° F.) in the southern part of the mainland, while in the northern section it ranges around 4.4° C. (40° F.); the average July temperature ranges from 26.7° to 27.8° C. (80° to 82° F.).

Mississippi has 82 spring localities, with a total of 110 springs, 10 of which have been analyzed. The state has a fair complement of mineral springs and, like those of neighboring states, are largely chalybeate in character. Few neighborhoods in the state are without mineral springs of some character, good, bad or indifferent; many copious springs issue from bluffs, the water flowing from beds of ocherous earth and pyritous clays. The waters are highly charged with the sulphate of iron, the habitual use of which is very pernicious. Many of the springs have considerable local reputation, and appear to be used indiscriminately by residents for medicinal purposes. Only a few of the springs have any commercial importance, only 4 reporting sales of water during the year 1923. The list given below was secured chiefly through the State Geologist and from correspondence and from published reports:

### Allison's Wells.

(*Lauderdale County.*)

*Postoffice*, Way. *Location*, in eastern Mississippi; east of Jackson, the capital city, 90 miles; north of Biloxi, 130 miles; south of Memphis, Tenn., 178 miles. *Situation*, in a beautiful park on the crest and sloping sides of a wooded hill, at an elevation of about 500 feet above sea level. *Access*, via Way Station, on the Illinois Central Railway, thence

by motor a short distance to the springs. *Hotel*, the hotel has been open since 1901; it is a commodious resort hostelry, with modern conveniences. The waters have been known for almost fifty years, and have quite a local reputation in diseases for which such waters are indicated. The analysis below shows the mineralization:

ALLISON'S WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Mississippi Geological Survey). | |
|---|---|---|
| | Well No. 2. | Well No. 3. |
| Calcium chloride ($CaCl_2$) | 0.617 | |
| Sodium chloride (NaCl) | 175.325 | |
| Potassium sulphate ($K_2SO_4$) | 11.775 | 22.985 |
| Sodium sulphate ($Na_2SO_4$) | 116.946 | 225.100 |
| Magnesium sulphate ($MgSO_4$) | ... | 832.489 |
| Calcium sulphate ($CaSO_4$) | 11.792 | 1292.569 |
| Ferrous sulphate ($FeSO_4$) | ... | 192.071 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 242.171 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 279.247 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 121.163 | 1110.449 |
| Aluminum oxide ($Al_2O_3$) | 3.994 | 256.414 |
| Silica ($SiO_2$) | 77.387 | 513.172 |
| Total solids | 866.878 | 4644.528 |

Well No. 2, medicinal classification, weak alkaline b, very weak ferruginous 1.5 or (−Ab, − −Fe 1.5). This is a moderately mineralized, sodic, sulphated and muriated and ferric calcic and magnesic bicarbonated, alkaline-saline water, possessing diuretic and tonic properties.

Well No. 3, medicinal classification, sulphated, weak ferruginous 3 or (S, −Fe3). This is a moderately highly mineralized, calcic, magnesic, ferric sulphated and ferrous bicarbonated acid water, possessing laxative, tonic and astringent properties.

These waters are recommended as highly beneficial in functional and chronic disorders of the stomach, bowels and kidneys. Bathing in the hot waters from Well No. 3 has been beneficial in the treatment of rheumatism and chronic skin diseases.

## Brown's Wells.

(*Copiah County.*)

*Postoffice*, Brown's Wells, via Hazelhurst. *Location*, in the central southwestern portion of the state; south of Jackson, the capital city, 40 miles; east of Port Gibson, on the Mississippi, 40 miles. *Situation*, in a beautiful 80-acre park, 600 feet above sea level. The park is in high rolling region, wooded with giant, long-leafed pine, majestic oak and the tropical live oak. *Access*, via Hazelhurst, on the main line of the Illinois Central Railway, thence by motor through a picturesque rolling country, over splended graded macadam highways, 10 miles to the hotels. *Hotels*, there are ample hotel accommodations. This

resort has been a favorite gathering place for people of means and fashion for more than a half century. The climatic conditions are so pleasant that golf can be enjoyed throughout the year. The mineral waters for which this place is famous comes from a number of wells, of which the following analyses show the mineralization:

BROWN'S WELLS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | | |
|---|---|---|---|---|---|---|
| | Analyst, A. M. Muchenfuss. | | Analyst, Prof. A. L. Metz. | | Analyst, A. L. Muchenfuss. | |
| | Well No. 1. | Well No. 2. | Well No. 3. | Well No. 4. | Well No. 6. | Well No. 7. |
| Lithium chloride (LiCl) | trace | trace | ... | trace | trace | trace |
| Sodium chloride (NaCl) | 67.88 | 70.64 | 106.67 | 94.96 | 25.65 | 91.95 |
| Magnesium chloride ($MgCl_2$) | ... | ... | ... | 20.61 | 20.61 | 1.43 |
| Potassium sulphate ($K_2SO_4$) | 10.43 | 35.80 | 154.52 | 24.47 | 33.89 | 22.80 |
| Sodium sulphate ($Na_2SO_4$) | 54.43 | 65.44 | 115.73 | | | |
| Magnesium sulphate ($MgSO_4$) | 575.75 | 600.21 | 351.92 | 372.95 | 71.66 | 711.45 |
| Calcium sulphate ($CaSO_4$) | 145.08 | 160.69 | 470.55 | 180.06 | 27.99 | 180.49 |
| Ferrous sulphate ($FeSO_4$) | ... | ... | 161.50 | | | |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | 65.80 | | | |
| Sodium nitrate ($NaNO_3$) | 0.30 | 0.66 | ... | 0.43 | 0.79 | 0.15 |
| Calcium bicarbonate($Ca[HCO_3]_2$) | 528.56 | 468.63 | 124.62 | 490.94 | 278.13 | 639.54 |
| Sodium bicarbonate ($NaHCO_3$) | 4.60 | 2.41 | ... | 50.87 | 3.35 | 2.51 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 35.53 | 64.52 | ... | ... | 6.90 | 3.27 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 152.96 | 85.17 | 3.07 | 228.99 | 1.33 | 388.17 |
| Aluminum oxide ($Al_2O_3$) | 10.50 | 1.69 | ... | 10.07 | | |
| Total solids | 1598.02 | 1555.96 | 1554.38 | 1461.45 | 470.30 | 2042.76 |

Wells No. 1 and 2, medicinal classification, weak alkaline b, weak sulphated 2, very weak ferruginous or (−Ab, −S2, − −Fe). These are quite similar in the percentage of their predominating chemical constituents. They are moderately highly mineralized, magnesic, calcic sodic sulphated, ferric bicarbonated alkaline water.

Well No. 3, medicinal classification, weak sulphated 3, very weak acid, aluminic, very weak ferruginous 2 or (−S3, − −AcAl, − −Fe2). This is a moderately mineralized, calcic magnesic, sodic, potassic ferric sulphated saline water.

Well No. 4, medicinal classification, weak alkaline b, weak sulphated, very weak ferruginous 3 or (−Ab, −S, − −Fe3). This is a moderately mineralized, calcic, magnesic, ferruginous, bicarbonated alkaline-saline water.

Well No. 6, medicinal classification, weak total mineralization or (−T). This is moderately mineralized, calcic bicarbonated alkaline water.

Well No. 7, medicinal classification, weak alkaline b2, weak sulphated 2, weak ferruginous or (−Ab2, −S2, −Fe). This is a magnesic, calcic, ferruginous, bicarbonated sulphated alkaline-saline water.

These waters are highly endorsed by the profession in a wide range of diseases, of the stomach, intestines, liver, gall ducts, kidneys and

bladder. Catarrhal conditions of the mucous membranes of the bowels are benefited by a course of these waters. Rheumatic and gouty affections and the uric-acid diathesis have been greatly relieved under the use of these waters. Brown's Wells offer many opportunities for rest and recuperation; golf and out-door sports are many and varied. Resident physician. Telephone and telegraph facilities.

### Castillian Springs.

(*Holmes County.*)

*Postoffice,* Durant. *Location,* in central Mississippi; north of Jackson, the capital city, 80 miles; south of Grenada, 75 miles; west of Kosciusco, 30 miles. *Situation,* on the west bank of the Big Black River and in the valley of same, at an elevation of about 300 feet above sea level. The springs issue forth in a beautiful park, well shaded with pine cedar, and wholly presenting a beautiful evergreen picture of rural beauty. *Access,* via Durant Station, on the Illinois Central Railway at the junction of the Yazoo & Mississippi Valley Railway, thence 3 miles by motor to the springs. *Hotel,* there are good hotel accommodations. The analysis below shows the mineralization:

CASTILLIAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. W. Hilgard). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 42.24 |
| Potassium sulphate ($K_2SO_4$) | 22.06 |
| Sodium sulphate ($Na_2SO_4$) | 148.60 |
| Calcium sulphate ($CaSO_4$) | 636.63 |
| Magnesium sulphate ($MgSO_4$) | 259.58 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 82.76 |
| Silica ($SiO_2$) | 125.78 |
| Total solids | 1317.65 |
| Flow in gallons per day | 7200 |

Medicinal classification, weak calcic sulphated 3 or (−CaS3). The analysis shows this to be a moderately highly mineralized, calcic, sodic, magnesic, sulphated, saline water, sulphuretted, possessing diuretic, slight tonic and alterative properties. These waters are highly endorsed in the treatment of bowel and stomach affections, particularly where eliminative action is desired. The iron content is liberal, and has been prescribed with success in all depraved conditions of the blood and blood-making organs.

### Cooper's Wells.

(*Hinds County.*)

*Postoffice,* Cooper's Wells, via Raymond. *Location,* in the western part of the state; southwest of Jackson, the capital city, 14 miles;

east of Vicksburg, 30 miles; south of Yazoo City, 40 miles; from Raymond, 4 miles. *Situation*, on a slight eminence, overlooking five deep valleys, in different directions, except toward the south, in which direction a high ridge, beautiful and well-cultivated, leads off, separating the waters of the Mississippi from Pearl River. *Access*, via Southern Railway to Raymond, thence by motor 4 miles, over a graded highway, leading through a beautiful, rolling, undulating country to Cooper's Wells. *Hotel*, the hotel accommodations are modern, with every convenience—baths, running hot and cold water.

A short distance from the hotel is a picturesque pavilion erected over the well, where thousands have made pilgrimages, during the past seventy-five years, seeking health through its health-building medicinal waters. The well is 104 feet deep, 4 feet square at the mouth, and narrows down toward the bottom. The first 30 feet were dug through hard clay, the next 30 feet were dug through sandstone rock and the rest of the depth was through shales of stones, etc. The bottom of the well is hollowed out of solid rock in the shape of a bowl; here 3 springs of water bubble up, coming from different directions, 1 tinged with red, 1 slightly darkened and 1 perfectly clear. It is a mysterious meeting of 3 streams of living water at this point, so far below the earth's surface. We present the chemist's report of the analysis which shows the following mineralization.

COOPER'S WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. J. L. Smith). |
|---|---|
| Sodium chloride ($NaCl$) | 142.956 |
| Calcium chloride ($CaCl_2$) | 74.804 |
| Magnesium chloride ($MgCl_2$) | 85.508 |
| Potassium sulphate ($K_2SO_4$) | 10.396 |
| Sodium sulphate ($Na_2SO_4$) | 94.810 |
| Calcium sulphate ($CaSO_4$) | 600.757 |
| Magnesium sulphate ($MgSO_4$) | 393.778 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 104.652 |
| Calcium crenate (Ca) | 5.318 |
| Ferrous peroxide ($Fe_2O_2$) | 57.490 |
| Silica ($SiO_2$) | 30.798 |
| Total solids | 1601.277 |
| Gases, cc. per liter: | |
| Oxygen | 0.785 |
| Nitrogen | 1.013 |
| Carbonic acid | 1.020 |

Medicinal classification, weak calcic sulphated 3, very weak acid aluminic 2, very weak ferruginous 2 or (−CaS3, − −AcAl2, − −Fe2). This is a moderately highly mineralized, calcic, magnesic, aluminic, sulphated, acid water, oxygenated, possessing laxative and tonic properties and having quite similar characteristics to the waters of Brocklet, near Kissengen in Bavaria. This combination of chemical constituents adapts this water for therapeutic use in numerous conditions

in which anemia is associated with constipation or catarrhal conditions of the alimentary tract. It exerts very satisfactory action in chlorosis and in chronic diarrhea. It acts as a diuretic or aperient, depending on the method and amount ingested.

### Lewis Mineral Wells.

(*Chickasaw County.*)

*Postoffice*, Woodland. *Location*, in northeastern Mississippi; northeast of Jackson, the capital city, 110 miles; south of New Albany, 45 miles; west of Aberdeen, 30 miles. *Situation*, in a rolling, hilly region, at an elevation of about 400 feet above sea level. The climate is mild and equable. The region is well watered and well drained. *Access*, via the Southern Railway System. *Hotel*, accommodations at Woodward. The analysis shows a remarkable mineralization:

LEWIS MINERAL WELL.

| Hypothetica combinations. | Parts per 1,000,000 (Analyst, W. F. Hand). |
|---|---|
| Sodium chloride ($NaCl$) | 408.738 |
| Potassium sulphate ($K_2SO_4$) | 54.762 |
| Sodium sulphate ($Na_2SO_4$) | 1603.396 |
| Calcium sulphate ($CaSO_4$) | 1267.709 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 3982.685 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 230.310 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 175.428 |
| Aluminum oxide ($Al_2O_3$) | 8.570 |
| Silica ($SiO_2$) | 411.531 |
| Total solids | 8198.936 |
| Gases: | |
| Oxygen, cc. per liter | 11.38 |

Medicinal classification, alkaline b2, sulphate, very weak ferruginous 2 or (Ab2, S, − −Fe2). This is a highly mineralized, magnesic, calcic ferruginous bicarbonated and sodic and calcic sulphated alkaline-saline (potassic) water, slightly carbon-dioxated, possessing diuretic, antacid, purgative, tonic and alterative properties. It is claimed to be a valuable remedy in the treatment of stomach, bowel and liver disorders. The sulphate radicles are in solution in sufficient amounts to stimulate bowel action, and should be a valuable water in the treatment of intestinal stasis, constipation, and act as a stimulant to hepatic function. The iron content, 175 mg. of the bicarbonate of iron to the liter, makes it a valuable tonic in doses of 1 liter daily.

### Ocean Springs.

(*Jackson County.*)

*Postoffice*, Ocean Springs. *Location*, on the extreme southern Gulf border of Mississippi; east of Bilox, 8 miles; east of New Orleans, La.,

83 miles. *Situation,* on the Mississippi Sound, overlooking the Gulf of Mexico to the south. The name of the springs is derived from their close proximity to the Gulf, the beach being but 1 mile away. *Access,* via the Louisville & Nashville Railway, main line. *Hotel,* there are good accommodations. The springs are resorted to by the citizens of New Orleans, Mobile and other nearby cities. The analysis shows the mineralization:

OCEAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. L.Smith). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | trace |
| Sodium chloride (NaCl) | 816.86 |
| Calcium chloride ($CaCl_2$) | 65.35 |
| Magnesium chloride ($MgCl_2$) | 84.98 |
| Potassium iodide (KI) | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 80.56 |
| Silica ($SiO_2$) | trace |
| Total solids | 1047.75 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 34.1 |
| Hydrogen sulphide, cc. per liter | 4.4 |

Medicinal classification, weak saline 2, very weak ferruginous or (−Cl2, −−Fe), sulphuretted. This is a moderately mineralized, sodic, magnesic, muriated, ferruginous saline (iodic, potassic) water, sulphuretted, possessing diuretic, slight laxative, tonic and alterative properties. The iron content no doubt in its normal state associated with carbonic acid is in the form of a bicarbonate, which, with the sodium chloride and the sulphuretted hydrogen, gives especially potent properties in the treatment of skin diseases and the scrofulous diathesis.

## Owens Mineral Wells.

(*Holmes County.*)

*Postoffice,* Owens. *Location,* in central Mississippi; north of Jackson, the capital city, 60 miles; northeast of Vicksburg, 80 miles; northwest of Meridian, 100 miles. *Situation,* on the west of the Big Black River and in the west valley of same, at an elevation of about 300 feet above sea level. The wells are within a beautiful landscaped park, traversed by meandering walkways and smooth hard-surfaced roadways. *Access,* via Illinois Central Railway System and connections. *Hotel,* there is a good hotel and additional cottages with bathhouses, all surrounded by beautiful shade trees. The analysis below shows the mineralization:

OWENS MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. F. Hand). |
|---|---|
| Sodium chloride ($NaCl$) | 190.83 |
| Potassium sulphate ($K_2SO_4$) | 4.16 |
| Sodium sulphate ($Na_2SO_4$) | 2.07 |
| Magnesium sulphate ($MgSO_4$) | 34.68 |
| Calcium sulphate ($CaSO_4$) | 246.94 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 202.02 |
| Ferrous sulphate ($FeSO_4$) | 72.25 |
| Aluminum oxide ($Al_2O_3$) | 0.92 |
| Silica ($SiO_2$) | 129.75 |
| Total solids | 1013.37 |

Medicinal classification, very weak acid aluminic 4, very weak ferruginous or (− −AcAl, − −Fe). The analysis shows a moderately highly mineralized, calcic, aluminic sulphated and sodic muriated, acid water, sulphuretted, possessing diuretic, slight laxative, tonic astringent and alterative properties. This water is especially recommended in catarrhal intestinal disorders, where elimination is desired, and in sluggish action of the hepatic function. The iron content makes the waters of value in the treatment of anemia and where there is depletion of the hemoglobin content of the blood.

## Robinson's Mineral Spring.

(*Madison County.*)

*Postoffice*, Pocahontas. *Location*, southwest of central Mississippi; north of Jackson, the capital city, 20 miles; northeast of Vicksburg, 40 miles. *Situation*, the situation is romantic, surrounded by Indian mounds, silent though convincing evidence that before the coming of the white man the red brother knew of this spring and there abided. The elevation is 380 feet above sea level. *Access*, via Pocahontas Station, on the Illinois Central Railway, thence by motor 3 miles to the springs. *Hotel*, there is an old colonial structure of commodious proportions, which a few years ago was converted into a sanitarium, for the treatment of patients and guests. There is a plan maturing to erect a modern sanitarium. The analysis shows the following mineralization:

ROBINSON'S MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Columbia Laboratory). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 140.39 |
| Potassium sulphate ($K_2SO_4$) | 8.91 |
| Sodium sulphate ($Na_2SO_4$) | 134.53 |
| Calcium sulphate ($CaSO_4$) | 116.88 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 110.84 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 33.48 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 27.73 |
| Silica ($SiO_2$) | 2.64 |
| Total solids | 575.40 |

Medicinal classification, weak total mineralization or (−T). The analysis shows this to be a moderately mineralized, sodic, muriated and sulphated, saline (ferruginous) water, possessing diuretic and tonic properties. The water has been widely used by physicians in the treatment of kidney and bladder troubles, rheumatism, uric-acid, diathesis, gout, etc.

## Stafford Springs.

*(Jasper County.)*

*Postoffice,* Stafford Springs. *Location,* in the southeastern portion of the state; north of Biloxi, about 100 miles; southeast from Jackson, the capital city, 70 miles. *Situation,* in a beautiful grove of towering gums, graceful sycamores, lofty poplars and long-leafed pines. *Access,* via the Southern Railway lines; all through trains from New Orleans to Cincinnati; stop at Vosburg, thence via motor 1½ miles to the springs. *Hotel,* there is a comfortable hostelry, with modern conveniences. The Stafford Springs water on analysis reveals the following mineralization:

STAFFORD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. H. Froehling). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.091 |
| Potassium chloride (KCl) | 1.353 |
| Sodium chloride (NaCl) | 8.150 |
| Potassium iodide (KI) | 0.017 |
| Sodium sulphate ($NaSO_4$) | 5.170 |
| Magnesium sulphate ($MgSO_4$) | 1.200 |
| Calcium sulphate ($CaSO_4$) | 6.400 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.108 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 17.060 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 234.050 |
| Ferrous bicarbonate ($Fe_2[HCO_3]_2$) | 4.490 |
| Aluminum oxide ($Al_2O_3$) | 0.110 |
| Silica ($SiO_2$) | 20.500 |
| Total solids | 309.017 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 7.41 |

This is a lightly mineralized, calcic, magnesic, bicarbonated alkaline water, flowing at the rate of 1000 gallons per hour, sparkling, pure and sweet. The water possesses diuretic, antacid and solvent properties; due to its iron and potassium, it exerts tonic and alterative properties. The water is highly endorsed by the profession all over the South; for the past twenty-five years it has been a popular remedy in the treatment of bladder and kidney disorders. It has been found to render excellent service in the treatment of Bright's disease and other disorders of the genito-urinary tract, where this class of waters are indicated.

## Iuka Mineral Springs.

(*Tishomingo County.*)

*Postoffice*, Iuka. *Location*, in the northeast corner of Mississippi. *Situation*, in the town of Iuka, near the head of Indian Creek, a tributory of the Mississippi. The springs are situated in a grove of grand old trees. The enclosure contains some 10 acres, intersected with concrete walks, only ½ mile from Lake Como. *Access*, via the Southern Railway System. *Hotel*, there is a large, comfortable hotel and several boarding houses. It is claimed that Iuka is one of the most popular spring resorts in the state. No definite information nor satisfactory analysis concerning the springs available, but below we give a condensed insight into the qualitative analyses of the springs:

Spring No. 1 (Iron Water). This spring contains: Peroxide of iron in great abundance; aluminum, small quantity; chloride of calcium; chloride of potassium; chloride of sodium; free carbonic acid; sulphates, in small proportion.

Spring No. 2 (Beauty Spring). Sulphuretted hydrogen; largely carbonate of iron; free carbonic acid, with small amount of bicarbonate of magnesium; bicarbonate of calcium; bicarbonate of potassium and the chlorides of potassium and sodium. It contains 1.1 per cent solid ingredients in 10,000 parts, five-sixths of which is peroxide of iron.

Spring No. 3. Bicarbonate of iron; free carbonic acid; a very small amount of bicarbonate of magnesium; bicarbonate of calcium; bicarbonate of potassium; bicarbonate of sodium; traces of chloride.

Spring No. 4 (Sulphur Water). Protosulphate of iron; sulphate of calcium; sulphate of sodium; carbonate of magnesium; chloride of calcium; sulphate of aluminum; earthy phosphates; iodine combined with magnesium.

Spring No. 5. Peroxide of iron; chloride of sodium; chloride of calcium, sulphate of calcium; sulphate of magnesium; sulphate of sodium; sulphuretted hydrogen gas; carbonic acid.

## Lauderdale Springs.

(*Lauderdale County.*)

*Postoffice*, Lauderdale. *Location*, in eastern Mississippi. *Situation*, in a gentle, rolling section of country, surrounded by wooded hills and fertile vales. The spring area is surrounded by a magnificent park, with stately old oaks, sturdy hickory and majestic elms, whose branches are festooned with long hanging Spanish gray moss, which presents a scenic picture of marvelous beauty. *Access*, via Lauderdale Station, on the Mobile & Ohio Railway, thence 1½ miles to the springs. *Hotel*, there is a commodious resort hostelry offering comfortable accommo-

dations. The bathing establishment is modern in equipment and construction. These springs are among the best known in the state. There are 3 springs in this area: No. 1, 45.56 parts total solids per 1,000,000; No. 2, 74.73 parts total solids per 1,000,000; No. 3, 3997 parts total solids per 1,000,000. Satisfactory analyses of these springs unavailable. These springs have their origin in the Wilcox formation. After becoming mineralized through contact with beds of lignite containing marcasite, the water is discharged through beds of sand. The waters from these springs have been used for many years, and they are among the best known mineral waters of the state. It is said that long before the Civil War these springs were discovered by General W. S. Patton during a deer hunt, that he afterward bought the surrounding land and started a town at that point, before the Mobile & Ohio Railroad was built. A resort was established; during the Civil War the hotel and other buildings were used as hospitals.

The following springs have been used as resorts:

*Belmont Springs, P. O.*, Buckatunna, Wayne County. Accommodations, cottages and cabins. This resort was known as Harmon Springs from 1819 to 1835, and was resorted to by the elite of the Southwest. The hotel buildings were destroyed in 1885. Twenty-five years ago the resort was revived and bid fair to recover most of its old-time popularity. The location is a delightful one, on a high ridge, 100 miles north of the Gulf of Mexico, at a considerable distance above sea level. The situation is in the valley of the Red Creek, a tributary of the Buckatunna. The waters are very cold, and emit a distinctly sulphurous odor. There are 2 springs, the Harmon and the Lake. No definite information nor satisfactory analysis available.

*Godbold Mineral Well, P. O.*, Summit, Pike County. Hotels and boarding houses in Summit. The location is 108 miles northeast of New Orleans. Altitude, 420 feet above tide water. The waters are said to possess valuable therapeutic properties, and were extensively used in diarrhea and dysentery of the kidneys. No definite information nor satisfactory analysis available.

*Quitman Red Sulphur Springs, P. O.*, Quitman, Clarke County. Two springs in the area, one a sulphur water and the other a ferruginous. No definite information nor satisfactory analysis available.

There are still a number of undeveloped springs in this state.

## MISSOURI.

Missouri extends from 36°30′ to 40°30′ north latitude and from 89°2′ to 95°50′ west longitude, and comprises an area of 69,415 square miles, of which 680 square miles is covered with water. The distance from the northern to the southern boundary is 285 miles, and the greatest distance from the eastern to the western boundary is slightly

more. The state is a vast expanse of gently rolling plains; north of the Missouri River, which bisects the state into two distinct parts, the surface is generally level, while to the south of the river it is undulating and becomes rougher and more mountainous as it approaches the Ozark Mountains, a broad dome-like elevation which rises to a height of 1800 feet above sea level. The climate of the state is subject to great extremes; the summers are long and in most portions very hot and oppressive, while the winters are very cold. However, despite these facts, the climate is very salubrious, and persons with pulmonary tuberculosis are said to get along quite well. The mean annual temperature, as observed at St. Louis, is 13° C. (55° F.); that of the summer, 24.4° C. (76.12° F.); that of the winter, 1° C. (32.90° F.). The southwestern winds from the arid plains in summer sometimes send the temperature up to 40° C. (104° F.), while the anticyclones of winter sometimes drop the mercury down to −23.3° C. (10° F. below zero).

Missouri has 133 spring localities, with a total of 441 individual springs, 28 of which have been analyzed, and 27 have at various times been used as resorts. Missouri contains numerous mineral springs, which are of great variety, though many of them have never received any attention, still several have during the past enjoyed some local popularity. The principal classes of water are viz: Saline, sulphuretted and chalybeate. Many of the counties have salt wells, and at one time the production of salt from them was an important industry. The older writers give scant attention to the mineral springs of this state. Walton mentions 1 locality and Crook lists only 10 localities, while Peale gives the information recorded in the first line of this paragraph. The list given herewith is made up from the State Geologist's report and from correspondence with physicians and spring owners and, while not complete, is fairly representative of the springs in active use today.

### Aurora Springs.

(*Miller County.*)

*Postoffice,* Aurora Springs. *Location,* near central Missouri; southeast of Jefferson City, the capital city, 35 miles; west of St. Louis, 120 miles. *Situation,* near the head waters of Saline Creek in a spur of the Ozark Mountains, rich in scenic beauty and natural grandeur, at an elevation of 1000 feet above sea level. *Access,* via the Jefferson City, on the Lebanon & Southwestern Railway, a branch of the Missouri Pacific System. *Hotel,* there are ample hotel facilities, with bathing departments for hot, cold and steam-mineral baths. There are quite a number of springs in this area. The following 4 are the more important ones—Round Spring, Bluff Spring, Healing Spring and Bath Spring. The analysis of Round Spring is given below:

AURORA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. B. Richardson). |
|---|---|
| Lithium chloride (LiCl) | 24.45 |
| Sodium chloride (NaCl) | 68.57 |
| Magnesium chloride ($MgCl_2$) | 118.84 |
| Calcium sulphate ($CaSO_4$) | 34.36 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 142.11 |
| Ferrous oxide ($Fe_2O_3$) | 15.90 |
| Silica ($SiO_2$) | trace |
| Total solids | 404.23 |

Medicinal classification, very weak ferruginous 2 or (− −Fe2). The analysis shows this to be a moderately mineralized, ferrous, bicarbonated, alkaline-saline water, possessing diuretic and tonic properties, the iron content being 142 mg. of the bicarbonate of iron to 1 liter of water. The celebrated Steel Spring at Pyrmont, Germany, contains only about one-half the iron content of the Aurora Spring. This water exerts a toning effect upon the economy, bracing up the digestion, stimulating the appetite and inducing sleep and increasing metabolism generally.

## Blue Lick Springs.

(*Saline County.*)

*Postoffice*, Marshall. *Location*, north of central Missouri; northwest of Jefferson City, the capital city, 65 miles; east of Kansas City, 80 miles. *Situation*, in the valley of Finneus Creek, a tributary of Blackwater Creek, at an elevation of about 1000 feet above sea level. *Access*, via the Missouri Pacific Railway to Marshall, thence by motor a short distance to the springs. *Hotel*, a number of cottages and private residences are the only accommodations. There are a number of springs in this area. The following analysis shows the mineralization:

BLUE LICK SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Missouri Geological Survey). | | | | | |
|---|---|---|---|---|---|---|
| | Blue Lick Spring. | Magnesian Spring. | Black Sulphur Spring. | Gum Spring. | Old Salt Spring. | Red Sulphur Spring. |
| Potassium chloride (KCl) | ... | 372.03 | ... | ... | 201.75 | 248.07 |
| Sodium chloride (NaCl) | 7026.25 | 9,469.33 | 16,167.89 | 22,898.07 | 22,044.85 | 22,095.14 |
| Magnesium chloride ($MgCl_2$) | 788.03 | 953.27 | 1,530.84 | 1,836.88 | 1,986.42 | 2,537.09 |
| Calcium chloride ($CaCl_2$) | 556.38 | 419.83 | 717.92 | 1,749.43 | 1,188.65 | 988.78 |
| Calcium sulphate ($CaSO_4$) | 672.56 | 880.39 | 1,508.98 | 1,923.97 | 1,932.29 | 1,830.69 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 479.55 | 975.18 | 1,259.05 | 757.55 | 1,111.30 | 723.90 |
| Aluminum oxide ($Al_2O_3$) | 1.69 | 17.36 | 1.09 | ... | ... | 61.92 |
| Silica ($SiO_2$) | 9.78 | 45.94 | 9.28 | 7.09 | 14.98 | 61.92 |
| Total solids | 8534.24 | 13,133.33 | 21,195.05 | 29,120.18 | 28,480.24 | 28,156.6 |

Gases: Hydrogen sulphide present in all the springs; amount not determined.

Blue Lick Spring, medicinal classification, saline 4 or (Cl 4), sulphuretted.

Magnesian Spring, medicinal classification, strong saline or (+Cl), sulphuretted.

Black Sulphur Spring, medicinal classification, strong saline 2 or (+Cl 2), sulphuretted.

The Gum Spring, medicinal classification, strong saline 2.5, calcic sulphated or (+Cl 2.5, CaS), sulphuretted.

Old Salt Spring, medicinal classification, strong saline 2.5, calcic sulphated or (+Cl 2.5, CaS), sulphuretted.

Red Sulphur Spring, medicinal classification, strong saline 2.6, calcic sulphated or (+Cl 2.6, CaS), sulphuretted.

The percentage of the predominating chemical constituents are so similar that we may class all 6 of these springs as highly mineralized, sodic, magnesic, calcic, muriated, sulphated, bicarbonated saline water, sulphuretted, possessing diuretic and laxative properties. It is claimed that these waters are beneficial in the treatment of kidney and bladder disorders and diseases of the bowels. Where there is constipation and stasis the sulphate radicles are present in sufficient amount to stimulate intestinal activity.

## Belcher Mineral Water Well.

*(St. Louis County.)*

*Postoffice*, Fourth Street and Lucas Avenue, St. Louis. *Location*, in eastern Missouri, on the Mississippi River; south of Springfield, Ill., 85 miles; east of Jefferson City, the capital city, 100 miles. *Situation*, in the heart of the metropolis of the Central West. *Access*, via Baltimore & Ohio Railway and the Chicago, Rock Island & Pacific Railway, the Chicago & Alton Railway; the Chicago, Burlington & Quincy Railway. *Hotel*, there is a modern fireproof structure, with a natural mineral water Turkish bath department. The bathing establishment is modern in construction and equipment, and contains all appurtenances necessary for a modern hydrotherapeutic establishment—mineral-water baths, vapor baths, massage, showers, swimming pool. The water on analysis shows the following mineralization:

BELCHER MINERAL WATER WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). |
|---|---|
| Potassium chloride (KCl) | 154.03 |
| Sodium chloride (NaCl) | 5995.39 |
| Magnesium chloride ($MgCl_2$) | 655.54 |
| Calcium chloride ($CaCl_2$) | 471.68 |
| Calcium sulphate ($CaSO_4$) | 780.99 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 28.14 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 296.29 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 14.62 |
| Silica ($SiO_2$) | 2.32 |
| Total solids | 8398.82 |

Medicinal classification, saline 4, weak calcic sulphated 2 or (Cl 4, −CaS2). The analysis shows this to be a highly mineralized, sodic, magnesic, calcic, muriated, sulphated saline water, sulphuretted, possessing diuretic and laxative properties. During the past fifty years these waters have been used successfully in the treatment of stomach, bowel and liver disorders, rheumatic and kindred affections. In connection with the Belcher bath and hotel there is conducted a modern fireproof European-plan hotel for women and men. The baths are available to patrons; direct access from rooms to the respective bath departments.

### Chalybeate Mineral Springs.

*(Livingston County.)*

*Postoffice*, Mooresville. *Location*, in the northwestern portion of the state; east of St. Joseph, 65 miles; northwest of Kansas City, 85 miles. *Situation*, in the fringe of timberland, 2 miles south of Grand River, on a tableland 923 feet above sea level. *Access*, via Mooresville Station, on the Chicago, Burlington & Quincy Railway, thence by motor 2 miles to the springs, or via motor over the national Pike's Peak Ocean to Ocean Highway. *Hotel*, there is a modern resort hostelry, with conveniences and good service. The analyses given below reveals the mineralization:

CHALYBEATE MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst Mo. Geol. Sur.) Well No. 1. | Analyst Paul Schweitzer. Well No. 2. |
|---|---|---|
| Sodium chloride (NaCl) | 41.04 | 36.77 |
| Potassium chloride (KCl) | 14.88 | 41.90 |
| Sodium sulphate ($Na_2SO_4$) | 23.83 | |
| Magnesium sulphate ($MgSO_4$) | 122.44 | 23.94 |
| Calcium sulphate ($CaSO_4$) | 477.03 | 79.69 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | 88.92 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 608.85 | 301.30 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.32 | 86.96 |
| Aluminum oxide ($Al_2O_3$) | 5.30 | |
| Silica ($SiO_2$) | 26.69 | 10.43 |
| Total solids | 1321.38 | 669.91 |
| Temperature, °C. | 15.6 | 16 |

Well No. 1, medicinal classification, weak alkaline b2, weak calcic sulphated 2 or (−Ab2, −CaS2). This is a moderately mineralized, calcic, bicarbonated and calcic sulphated saline water, possessing diuretic and antacid properties. It has been used with success in the treatment of disorders of the genito-urinary tract and in catarrhal diseases of the intestinal tract, rheumatism and resultant ills.

Well No. 2, medicinal classification, very weak ferruginous or

(− −Fe). This is a moderately mineralized, calcic and ferruginous bicarbonated and aluminic sulphated, alkaline-saline water, possessing diuretic, tonic, astringent and alterative properties. This water is valuable in the treatment of inflammatory disorders of the intestinal tract. It is a valuable tonic in neurasthenia and all depleted conditions of the blood and blood-making organs. It is useful wherever an iron tonic is indicated; its administration will increase the hemoglobin content of the circulatory system.

## Eldorado Springs.

(*Cedar County.*)

*Postoffice*, Eldorado Springs. *Location*, in western Missouri; southwest of Jefferson City, the capital city, 110 miles; east of Fort Scott, Kan., 50 miles; southeast of Kansas City, 110 miles. *Situation*, amidst the northern foothills of the outlying spurs of the Ozark Mountains, at an elevation of about 1200 feet above sea level. *Access*, via Hardwood Station, on the Missouri, Kansas & Texas Railroad, connections with the Missouri Pacific Railway System, thence a distance of 12 miles to the springs. There are commodious hotel accommodations and several bathing establishments. The water shows on analysis the following mineralization.

ELDORADO SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, J. W. Marden). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | faint trace |
| Potassium chloride (KCl) | heavy trace |
| Sodium chloride (NaCl) | 438.86 |
| Sodium sulphate ($Na_2SO_4$) | 7262.26 |
| Magnesium sulphate ($MgSO_4$) | 425.18 |
| Calcium sulphate ($CaSO_4$) | 845.23 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 53.55 |
| Silica ($SiO_2$) | 43.12 |
| Total solids | 9068.20 |

Medicinal classification, sulphate 4 or (S4). The analysis shows a highly mineralized, sodic sulphated, saline (ferruginous) water, possessing diuretic and slight laxative properties. It is highly recommended for the relief of constipation and catarrhal diseases of the intestinal tract; its action also stimulates the hepatic function, increasing the flow of bile.

## Excelsior Springs.

(*Clay County.*)

*Postoffice*, Excelsior Springs. *Location*, in western Missouri, near the Kansas boundary line; northeast of Kansas City, 30 miles; northeast of Topeka, Kan., 85 miles; north of Independence, 25 miles. *Situa-*

*tion*, in a beautiful valley, surrounded by rugged hills and a fertile agricultural section of country. The climatic conditions are salubrious and delightful during the spring and summer; the winters are crisp and sometimes very cold. *Access*, via the Illinois Central Railway connections. *Hotel*, there are good hotel accommodations, and the bathing establishment connected with the hotel is modern in construction and equipment. There are a number of springs within this area, and the analyses below show the mineralization of the 2 more important springs:

EXCELSIOR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. P. Mason). | |
|---|---|---|
| | Regent Spring. | Sulpho-saline Spring. |
| Potassium chloride (KCl) | 2.79 | |
| Sodium chloride (NaCl) | 17.56 | 10,359.07 |
| Magnesium chloride ($MgCl_2$) | ... | 398.12 |
| Sodium iodide (NaI) | ... | trace |
| Potassium sulphate ($K_2SO_4$) | 4.85 | 31.87 |
| Magnesium sulphate ($MgSO_4$) | ... | 14.10 |
| Calcium sulphate ($CaSO_4$) | ... | 14,372.27 |
| Sodium hydrosulphide (NaHS) | ... | 7.34 |
| Sodium bicarbonate ($NaHCO_3$) | 9.33 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 94.87 | 263.08 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 14.50 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 585.86 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 71.75 | |
| Aluminum oxide ($Al_2O_3$) | 2.10 | |
| Silica ($SiO_2$) | 11.97 | 10.97 |
| Total solids | 815.58 | 25,458.77 |
| Flow in gallons per day | 7200 | very large |

Regent Spring, medicinal classification, weak alkaline b2, very weak ferruginous or (−Ab2, −−Fe). This is a moderately mineralized, calcic, magnesic, ferruginous, bicarbonated, alkaline (manganic) water, possessing diuretic, antacid, tonic and alterative properties. This water is valuable in the treatment of anemia, chlorosis and in all depraved conditions of the blood and blood-making organs.

Sulpho-saline Spring, medicinal classification, strong calcic sulphated 1.5, strong saline or (+CaS 1.5, +Cl). This is a highly mineralized, sodic, muriated and calcic sulphated saline water, possessing diuretic, tonic and slight laxative properties. This water is of value in the treatment of catarrhal disorders of the gastro-intestinal tract, constipation and hepatic disturbances, etc.

## Old Orchard Mineral Springs.

(*St. Louis County.*)

*Postoffice*, 609 Sunnyside Avenue, Webster Groves. *Location*, in the extreme eastern portion of the state; west of St. Louis, 10 miles. *Situation*, in a magnificent grove of stately trees, surrounded by a

beautiful rolling country, well drained and healthy. *Access*, via Frisco Railway, depot only 3 short blocks from the springs. *Hotel*, no accommodations for guests. The analysis shows the following mineralization:

OLD ORCHARD MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. H. Keiser). |
|---|---|
| Potassium chloride (KCl) | 17.4 |
| Sodium chloride (NaCl) | 45.7 |
| Sodium sulphate ($Na_2SO_4$) | 67.1 |
| Sodium bicarbonate ($NaHCO_3$) | 27.4 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 313.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 620.4 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 66.1 |
| Calcium silicate ($CaSiO_3$) | 14.1 |
| Total solids | 1171.5 |
| Radio-activity, Mache units per liter | 1.2 |

Medicinal classification, weak alkaline b3 or (−Ab3), very weak radio-active. This is a moderately mineralized, calcic, magnesic, bicarbonated alkaline water, with weak radio-active properties. The water exerts a diuretic action and has tonic properties. It enjoys a local reputation for relief in gastric and genito-urinary disorders. The spring flows at the rate of 36,000 gallons daily. The waters have a large commercial sale. A modern bottling plant insures the sanitary handling of the water.

## O-Sa-Ke-Tah Springs.

(*Vernon County.*)

*Postoffice*, Nevada. *Location*, on the western border of Missouri; south of Kansas City, 100 miles; north of Joplin, 55 miles; southwest of Jefferson City, the capital city, 140 miles. *Situation*, in a beautiful 200-acre park, not far distant from the outlying foothills of the northern slope of the Ozark Mountains, at an elevation of about 1000 feet above sea level. There is a 30-acre lake in the center of this park, which adds much to the sylvian beauty of the surroundings. *Access*, via three railroads: Missouri, Kansas & Texas Railway, the Missouri Pacific Railway and the Nevada & Minden Railway, thence a distance of 2 miles by motor to the springs. *Hotels*, there is a modern summer resort hostelry with home-like conveniences. The lake is supplied from an artesian well, flowing at the rate of 10,000 gallons per hour; the surplus water forming the lake some 8 or 10 acres in extent, in the midst of which is a beautiful island with bandstand and other amusements, which at night, lighted with electricity, presents a Venetian scene of great beauty and attractiveness. There are 3 springs in this area—O-sa-ke-tah, Iron and Clear Water. The analysis below shows the mineralization of O-sa-ke-tah Spring:

O-SA-KE-TAH SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, H. P. Corson). |
|---|---|
| Potassium chloride (KCl) | 51.10 |
| Sodium chloride (NaCl) | 770.30 |
| Magnesium chloride ($MgCl_2$) | 52.30 |
| Magnesium sulphate ($MgSO_4$) | 81.10 |
| Potassium nitrate ($KNO_3$) | 1.10 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 26.89 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 321.89 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.64 |
| Aluminum oxide ($Al_2O_3$) | 2.05 |
| Silica ($SiO_2$) | 11.00 |
| Organic matter | 1.80 |
| Total solids | 1329.17 |

Medicinal classification, weak saline 2 or (−Cl 2). The analysis shows this to be a moderately highly mineralized, sodic, muriated and calcic bicarbonated alkaline-saline (potassic) water, sulphuretted, possessing diuretic, antacid and slight tonic properties. The waters are used with success in the treatment of digestive disturbances due to acidity, in catarrhal conditions of the intestinal tract and in mild irritations of the genito-urinary tract. Unlike some resorts, the waters here are free to all who care to partake of them.

## Paris Chalybeate Springs.

(*Lawrence County.*)

*Postoffice,* Paris Springs. *Location,* in southwestern Missouri; southwest of Jefferson City, the capital city, 150 miles; east of Joplin, 50 miles. *Situation,* at the foot of an outlying spur of the Ozark Mountains, at an elevation of 1500 feet above sea level. *Access,* via Kansas City, Fort Scott & Gulf Railway to Ash Grove, thence by motor, over good macadam highways, through a picturesque region, 10 miles to the springs. *Hotel,* there is a good resort hotel and cottages with conveniences. The spring on analysis reveals the following mineralization:

PARIS CHALYBEATE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Litton). |
|---|---|
| Magnesium chloride ($MgCl_2$) | 23.00 |
| Potassium sulphate ($K_2SO_4$) | 37.00 |
| Sodium sulphate ($Na_2SO_4$) | 65.00 |
| Magnesium sulphate ($MgSO_4$) | 37.00 |
| Calcium sulphate ($CaSO_4$) | 355.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 40.88 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 486.00 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 10.22 |
| Silica ($SiO_2$) | 13.00 |
| Total solids | 1067.10 |
| Flow in gallons per day | 2880 |
| Gases: | |
| Carbon dioxide, cc. per liter | 21.5 |

Medicinal classification, weak alkaline b, weak calcic sulphated or (−Ab, −CaS3). This is a moderately mineralized, calcic, sulphated and bicarbonated, alkaline-saline (ferruginous potassic) water, slightly carbon-dioxated, possessing diuretic, antacid, aperient and tonic properties. It is claimed that patients suffering from disorders of the liver, kidneys, stomach, skin nervous system are greatly benefited by a "drinking cure" and a sojourn at the springs. The iron content is an assimilable form, and is indicated in anemia and all depraved states of the blood and blood-making organs.

## Radium Springs.

(*Barry County.*)

*Postoffice,* Seligman. *Location,* in southern Missouri; northwest of Eureka Springs, Ark., 12 miles; southwest of of Jefferson City, the capital city, 145 miles; southeast of Fort Scott, Kan., 100 miles; southwest of Springfield, 65 miles. *Situation,* in the Ozark Mountains the general elevation is about 1000 feet above sea level. *Access,* via the Frisco System of the Atchison, Topeka & Santa Fe Railway System. *Hotel,* no information available as to class of accommodations. This spring on analysis shows the following mineralization:

RADIUM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, O. E. Sheppard). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.148 |
| Potassium chloride (KCl) | 2.350 |
| Sodium chloride (NaCl) | 4.240 |
| Magnesium chloride ($MgCl_2$) | 5.220 |
| Magnesium sulphate ($MgSO_4$) | 6.180 |
| Calcium sulphate ($CaSO_4$) | 2.760 |
| Sodium nitrate ($NaNO_3$) | 0.004 |
| Sodium nitrite ($NaNO_2$) | trace |
| Calcium phosphate ($Ca[PO_4]_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 208.550 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.370 |
| Silica ($SiO_2$) | 11.870 |
| Total solids | 242.692 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 12.50 |
| Carbon dioxide set free on evaporation, cc. per liter | 47.41 |
| Sulphuretted hydrogen present. | |
| Radio-activity marked. | |

Medicinal classification, sulphuretted, radio-activated. This is a lightly mineralized, calcic, bicarbonated alkaline water, slightly carbon-dioxated, sulphuretted and radio-activated, possessing diuretic, antacid and tonic properties. It is useful in the treatment of gastric disturbance due to acidity and in bladder and kidney affections.

## Siloam Springs.

*(Howell County.)*

*Postoffice*, Siloam Springs. *Location*, in southern Missouri; south of Jefferson City, the capital city, 160 miles; southwest of St. Louis, 185 miles; north of Little Rock, Ark., 145 miles. *Situation*, in a natural amphitheatre on the southern slope of the Ozark Mountains, at an altitude of 1200 feet above sea level, amid a veritable forest of oak, hickory, pine and other indigenous trees, in which the stately pine predominates. *Access*, via West Plains Station, on the St. Louis & San Francisco Railway, thence by motor, over a splendid highway leading through an interesting mountain section, 15 miles to the springs. *Hotel*, there are two hotels, both modern in construction and equipment, offering home-like conveniences. In addition, there are 20 cottages, furnishing additional accommodations for those who desire privacy and seclusion. There is a well-equipped bathing establishment, modern in every particular. Surrounding the hotels and spring area is a 200-acre park, well landscaped and beautified. Within the confines of this park is a magnificent golf course, possessing some very unique features and natural hazards, which is a mecca for the devotees of this game. The springs, 7 in number, issue from the sides of a ravine-like formation covered with cherty boulders, dislodged from the limestone formation of the Ozark series, probably near the lower levels. Besides the Siloam Spring, there are Sulphur Spring, Keystone Spring, Iron Spring and several others. The analysis of the Siloam Spring is given below which shows the mineralization:

SILOAM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, unknown). |
|---|---|
| Sodium chloride ($NaCl$) | 17.3 |
| Magnesium chloride ($MgCl_2$) | 10.1 |
| Magnesium sulphate ($MgSO_4$) | 6.4 |
| Magnesium nitrate ($MgNO_3$) | 44.6 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 211.4 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 305.8 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 5.0 |
| Total solids | 600.6 |
| Temperature, °C. | 14.4 |
| Flow in gallons per day | 1100 |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic, bicarbonated, nitrated alkaline water, carbon-dioxated and sulphuretted, possessing diuretic and antacid properties. The waters have been highly endorsed by the profession in the treatment of gout, rheumatism and the uric-acid diathesis, in digestive disorders due to acidity and hyperacidity and in chronic

hepatitis and in renal and bladder disturbances. These springs have been popular as a resort for more than a hundred years, and have a very interesting history dating back to 1817. The demand for the waters throughout this and adjoining states has created a water shipping business to supply patrons who find it difficult to leave home. (See also Chapter XV.)

### Sweet Springs.

(*Saline County.*)

*Postoffice*, Sweet Springs. *Location*, in northeastern part of Central Missouri; northwest of Jefferson City, the capital city, 80 miles; east of Kansas City, 70 miles; south of Chillicothe, 60 miles. *Situation*, in the valley of Blackwater Creek, at an elevation of about 1000 feet above sea level. *Access*, via Sweet Springs Station, on the Missouri Pacific Railway, thence 1 mile by motor to the springs. *Hotel*, there is a commodious and modern resort hostelry, with cottages and bungalows. There is a well-arranged bathing establishment run in connection with the hotel and a large out-door swimming pool for the use of guests. The springs flow from a fault in the limestone strata far below the surface soil. The analysis below shows the mineralization of the various springs:

SWEET SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Missouri Geological Survey). | | |
|---|---|---|---|
| | Sweet Spring. | Akesion Spring. | Salt Spring. |
| Potassium chloride (KCl) | 0.79 | 92.35 | 167.83 |
| Sodium chloride (NaCl) | 1689.39 | 15,085.51 | 15,254.75 |
| Magnesium chloride ($MgCl_2$) | 375.75 | 1,530.59 | 1,511.70 |
| Calcium chloride ($CaCl_2$) | 188.78 | 1,457.22 | 1,846.74 |
| Calcium sulphate ($CaSO_4$) | 160.44 | 956.46 | 972.73 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 428.42 | 903.61 | 482.56 |
| Aluminum oxide ($Al_2O_3$) | 2.19 | 3.39 | 1.82 |
| Silica ($SiO_2$) | 5.29 | 5.39 | 4.93 |
| Total solids | 2830.75 | 19,134.52 | 20,245.06 |
| Flow in gallons per day | ... | 96,000 | 96,000 |

Sweet Spring, medicinal classification, weak alkaline b, saline or (−Ab, Cl). This is a moderately highly mineralized, sodic, magnesic calcic, muriated, saline water, possessing diuretic and aperient properties.

Akesion Spring, medicinal classification, strong saline 2 or (+Cl2). This is a highly mineralized, sodic, calcic, magnesic muriated saline water, sulphuretted, possessing diuretic and aperient properties.

Salt Spring, medicinal classification, strong saline 2 or (+Cl 2).

This is a highly mineralized, sodic, calcic, magnesic muriated, saline water, sulphuretted, possessing diuretic and aperient properties.

The following springs were once used as resorts:

*B. B. Mineral Springs, P. O.*, Bowling Green, Pike County. There 2 springs in this area, of the calcic, sodic magnesic, sulphated type. No definite information nor satisfactory analysis available.

*Climax Springs, P. O.*, Climax, Camden County. There are 7 springs in this area located in a heavily timbered region. One of the springs is remarkable on account of the amount of iodine and bromine contained. No definite information nor satisfactory analysis available.

*Lotus Springs, P. O.*, Greenfield, Dade County. Located in the Ozark Mountains, 1400 feet above sea level. The water at one time enjoyed a reputation as a remedy in gastric and renal disorders. No definite information nor satisfactory analysis available.

*The Montesano Springs, P. O.*, Sulphur Springs Landing, Jefferson County. Correspondence with the owner advises the place is no longer used as a resort. There are 6 springs in this area, and the waters are said to possess laxative properties. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Aperient Well, P. O.*, Eldorado Springs, Cedar County.
*Bokert Springs, P. O.*, De Soto, Jefferson County.
*Chateau Springs, P. O.*, Boonville, Cooper County.
*Claymount Springs, P. O.*, Randolph, Clay County.
*Crystal Mineral Springs, P. O.*, Excelsior Springs, Clay County.
*Crystal Spring, P. O.*, Kansas City, Jackson County.
*Cusenbary Spring, P. O.*, Mount Washington, Jackson County.
*Grand River Mineral Spring, P. O.*, Mercer, Mercer County.
*Haymaker Springs, P. O.*, Lineville, Iowa, Mercer County.
*Hornet Springs, P. O.*, Bowling Green, Pike County.
*Morris Mineral Springs, P. O.*, Eldorado Springs, Cedar County.
*Musick Mineral Well, P. O.*, Eldorado Springs, Cedar County.
*Natrona Spring, P. O.*, Excelsior Springs, Clay County.
*Regent, Siloam, Sulpho-saline* and *Soterian Springs, P. O.*, Excelsior Springs, Clay County.
*Relief Water County Well, P. O.*, Excelsior Springs, Clay County.
*Saline Soda Well, P. O.*, Excelsior Springs, Clay County.
*Salt Sulphur Well, P. O.*, Excelsior Springs, Clay County.

## MONTANA.

Montana extends from 44°25′ to 49° north latitude, and from 104° to 116° west longitude, and embraces an area of 146,080 square miles, of which 770 square miles are covered by water. From east to west the distance across the state is 550 miles and from north to south the distance is 275 miles. The eastern three-fifths of the state con-

sists of rolling plains, lying at an elevation of 2000 feet in the northeast to about 4000 feet at the foothills of the Rocky Mountains; in the western portion of the state some of the highest peaks rise from 8000 to 11,300 feet above the sea level. The main divide runs from Yellowstone National Park, along the southwestern boundary, turning eastward, crosses the state obliquely in a northwest direction. The scenery in many parts is grand and impressive. The climate is milder than the latitude and elevation would suggest, the mean annual temperature, as observed at Helena, being 6° C. (43.04° F.); that of summer, 22° C. (70.28° F.); that of winter, −7° C. (19.16° F.). There is a great annual range of temperature, in midwinter sometimes the mercury dropping to −34.4° C. and −40° C. (30° F. and 40° F. below zero).

Montana has 42 spring localities, with a total of 200 individual springs, 8 of which have been analyzed, and at various times 8 have been used as resorts. The mineral springs of Montana are numerous, and many are important and interesting, although very little has been written about them. Walton mentions only 1 locality and Crook mentions only 7. This perhaps is due to two causes: Montana until recent years has been more or less isolated and comparatively little was known about its mineral waters, and again the close proximity to the great Yellowstone National Park, and the fact that the readiest access to the Park was through Montana has served to attract some attention to the springs of Montana. The majority of the springs are found in the western part of the state in the mountainous regions and are thermic, sulphuretted, carbonated, alkaline, saline, chalybeate and calcic, closely resembling the celebrated waters of the Apollinaris Spring of Prussia. Very few of the mineral springs have been analyzed, and the character of the majority of them is unknown; still a number of localities hve been improved, and the curative properties of many of the waters are well known. The following list has been secured largely through H. B. Foote, State Geologist, from personal inquiry and from correspondence with spring owners, and is fairly representative of the springs in active use at the present time.

### Alhambra Hot Springs.

(*Jefferson County.*)

*Postoffice,* Alhambra. *Location,* southwest of central Montana; south of Helena, the capital city, 17 miles; south of Great Falls, 70 miles; north of Boulder, the county seat, 15 miles. *Situation,* at the mouth of Warm Springs Canyon, at the confluence of Prickly Pear and Warm Springs Creek, at an elevation of 4200 feet above sea level. *Access,* on the main line of the Great Northern Railway, between Butte and Helena. *Hotel,* there is a modern hostelry, with conveniences, steam heat and electric light. The bathing establishment

is under the same management as the hotel and is modern in construction and equipment. Besides the large plunge bath in the main bath-house, there are separate vapor, mud and plunge baths for both men and women. A competent physician directs the baths and the hospital department, which became necessary to accommodate the great number of sufferers resorting here for the relief of chronic articular and metabolic disorders. The analysis herewith shows the mineralization:

ALHAMBRA HOT SPRINGS.

| Hypothetica combinations. | Parts per 1,000,000 (Analyst, Montana State Board of Health). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 35.00 |
| Sodium sulphate ($Na_2SO_4$) | 232.00 |
| Sodium bicarbonate ($NaHCO_3$) | 850.50 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 21.06 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 129.60 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 5.00 |
| Silica ($SiO_2$) | 62.00 |
| Total solids | 1335.16 |
| Temperature, °C. | 54.4 |

Medicinal classification, weak alkaline a3 or (−Aa3), thermic. The analysis shows this to be a moderately highly mineralized, thermic, sodic, muriated, sulphated, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic, antacid and tonic properties. These waters are highly recommended in chronic rheumatism, rheumatic arthritis, sciatica and neuritis, renal and vesical calculi, hepatic congestion. The drinking cure with these waters is beneficial in all gastric disturbances due to acidity, which it neutralizes, inducing a healthful tonic effect upon the bowels; therefore, it is indicated in chronic constipation and general autointoxication, etc.

## Bozeman Hot Springs.

*(Gallatin County.)*

*Postoffice*, (Star Route) Salesville. *Location*, west of Bozeman, 7 miles; north of Yellowstone National Park, 90 miles. *Situation*, on the west bank of the Gallatin River, near the center of the beautiful Gallatin Valley, 4500 feet above sea level; a favored spot, walled in by the Majestic Rocky Mountains, snow-capped, rock-ribbed, majestic peaks. *Access*, via branch line of the Milwaukee Railway from Three Forks to Bozeman, with depot on the spring property; also via motor stage over surfaced national highway from Yellowstone National Park to points beyond the springs, daily schedule. *Hotels*, individual cottages and bungalows with screened piazzas offer homelike accommodations. A large swimming pool with natural hot water,

and, after cold showers, individual dressing rooms, etc., for the comfort of guests. The following analysis shows the mineralization of the water:

BOZEMAN HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. M. Cobleigh). |
|---|---|
| Sodium chloride (NaCl) | 91.0 |
| Sodium sulphate ($Na_2SO_4$) | 242.0 |
| Sodium carbonate ($Na_2CO_3$) | 52.0 |
| Sodium bicarbonate ($NaHCO_3$) | 61.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 16.0 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.8 |
| Silica ($SiO_2$) | 52.0 |
| Total solids | 514.8 |

Medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, sodic, sulphated, alkaline-saline water, flowing at the rate of 600 gallons per minute, possessing laxative and tonic properties. For the past forty years these waters have been endorsed by the profession and used with success in the treatment of gout, rheumatism, diseases of the liver and kidneys. The hot baths are given under medical supervision and are of great value in the treatment of rheumatic arthritis and skin affections. The place is conducted as a summer resort only, but plans are under way for the erection of a handsome modern hotel with all conveniences, and a new modern bathing establishment, equipped to carry out the latest teachings of hydrotherapy and balneotherapy.

## Broadwater Hot Springs.

(*Lewis and Clark County.*)

*Postoffice,* Helena. *Location,* in midwestern Montana; south of Great Falls, 75 miles; north of Virginia City, 90 miles; northwest of the Yellowstone National Park, 130 miles. *Situation,* in the heart of the great Rocky Mountains, east of the Bitter Root Range, at an elevation of about 5200 feet above sea level. *Access,* via the Northern Pacific Railways and the great national highways traversing the country from coast to coast. *Hotel,* there is a modern hostelry, offering every convenience and appointment. The bathing establishment is modern in construction and equipment. The large natatorium is 300 feet long by 100 feet wide, 3 feet in depth at one end and 9 feet at the other.

Medicinal classification, weak total mineralization or (−T), thermic. The analysis shows this to be a moderately mineralized, thermic, sodic, sulphated and muriated, alkaline-saline water, possessing diuretic, antacid and slight tonic properties. These properties of the water, coupled with its temperature recommends it at once, either

in the form of baths or for internal consumption in various disorders of the digestive tract and in affections of the liver and kidneys. Many chronic joint affections and rheumatic disturbances are benefited by the hot baths.

BROADWATER HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. Starz, Ph.G.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 24.56 |
| Sodium chloride (NaCl) | 47.70 |
| Sodium sulphate ($Na_2SO_4$) | 253.60 |
| Potassium nitrate ($KNO_3$) | 1.10 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 11.70 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 40.50 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.16 |
| Alumnium oxide ($Al_2O_3$) | 3.86 |
| Silica ($SiO_2$) | 68.50 |
| Total solids | 451.68 |
| Temperature, °C. | 71.1 |
| Flow in gallons per day | 20,000 |

## Boulder Hot Springs.

*(Jefferson County.)*

*Postoffice,* Boulder. *Location,* in southwestern Montana; south of Helena, the capital city, 30 miles; south of Great Falls, 90 miles; northwest of Billings, 190 miles. *Situation,* in the heart of the Rocky Mountains, east of the Bitter Root Range, at an elevation of about 5200 feet above sea level. *Access,* via the Northern Pacific Railway and the great national highways traversing the country from coast to to coast. *Hotel,* the class of hotel accommodations could not be ascertained with definiteness. Analysis below shows the type of mineralization:

BOULDER HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Montana Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 33.00 |
| Sodium sulphate ($Na_2SO_4$) | 277.00 |
| Sodium bicarbonate ($NaHCO_3$) | 260.82 |
| Magnesium bicarbonate ($MgHCO_3$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 17.82 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.00 |
| Silica ($SiO_2$) | 104.00 |
| Total solids | 693.64 |

Medicinal classification, weak total mineralization 2 or (−T2). The analysis shows this to be a moderately mineralized, thermic, sodic, sulphated, muriated and bicarbonated alkaline-saline water, possessing diuretic, antacid and tonic properties, useful in the treatment of

gastric and intestinal disorders, especially constipation and chronic stasis, resulting from autointoxication. The sulphate ions are in solution in sufficient quantity to stimulate bowel action and liquefy the secretions. The hot baths are advantageous in the treatment of chronic rheumatic and arthritic disorders, chronic skin diseases, etc.

### Camas Hot Springs.

(*Saunders County.*)

*Postoffice*, Camas. *Location*, in northwestern Montana; northwest of Helena, the capital city, 150 miles; north of Missoula, 45 miles. *Situation*, on the eastern slope of the Cœur-d-alene Range of mountains, at an elevation of about 8000 feet above sea level. *Access*, via the Northern Pacific Railway. *Hotel*, information meagre as to the character of accommodations. The analysis below shows the mineralization:

CAMAS HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Montana Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 12.00 |
| Sodium sulphate ($Na_2SO_4$) | 9.00 |
| Sodium bicarbonate ($NaHCO_3$) | 208.14 |
| Magnesium bicarbonate ($MgHCO_3$) | 1.62 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 13.60 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.00 |
| Silica ($SiO_2$) | 63.00 |
| Total solids | 308.96 |

The analysis shows this to be a lightly mineralized, sodic, bicarbonated, muriated alkaline water, possessing diuretic and antacid properties. The hot baths and drinking cure of this water is said to be useful in gastro-intestinal disorders, bladder and kidney troubles and rheumatic and chronic joint diseases.

### Hunter's Hot Springs.

(*Park County.*)

*Postoffice*, Hunter's Hot Springs. *Location*, in midsouthern Montana; southeast of Helena, the capital city, 110 miles; east of Bozeman, 50 miles; west of Billings, 100 miles; northeast of Livingston, the county seat, 25 miles. *Situation*, in the heart of the Rocky Mountains, at an elevation of 5000 feet above sea level. *Access*, via the Northern Pacific Railway and Burlington Railway to Springdale Station, thence by motor 2 miles to the springs, or by motor over the Yellowstone Trail, midway between St. Paul and Seattle. *Hotel*, the hotel is a magnificent structure of pleasing Spanish architectural design with all modern conveniences. The bathing establishment is modern in construction and equipment and fitted to offer every form

of balneotherapeutic treatment under the supervision of a competent resident physician and a corps of trained assistants. The popularity of these waters and water cures have attracted many thousands during the past thirty years. The analysis below shows the mineralization:

HUNTER'S HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst unknown). |
|---|---|
| Potassium chloride (KCl) | 45.15 |
| Sodium chloride (NaCl) | 2.56 |
| Potassium sulphate ($K_2SO_4$) | 28.72 |
| Sodium sulphate ($Na_2SO_4$) | 23.59 |
| Magnesium sulphate ($MgSO_4$) | 120.89 |
| Calcium sulphate ($CaSO_4$) | 26.16 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 106.65 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 45.15 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.43 |
| Aluminum oxide ($Al_2O_3$) | 3.59 |
| Silica ($SiO_2$) | 34.20 |
| Total solids | 441.09 |
| Temperature, °C. | 64.4 |

Medicinal classification, weak total mineralization or (−T), thermic. The analysis shows this to be a moderately mineralized, thermic, magnesic, calcic, sulphated and bicarbonated alkaline-saline water, carbondioxated, possessing diuretic, antacid and tonic properties. For many years Hunter's Hot Springs have been resorted to by sufferers from rheumatism, chronic arthritis, sciatica, neuritis, etc., and those suffering from liver, kidney and stomach disorders derive much benefit from the waters. Chronic skin affections are also benefited from a course of baths and the drinking cures.

## Lo Lo Hot Springs.

(*Missoula County.*)

*Postoffice*, Lo Lo Hot Springs. *Location*, in extreme western Montana; west of Helena, the capital city, 145 miles; west of Missoula, the county seat, 40 miles. *Situation*, on the eastern slope of the Bitter Root Mountains, at an elevation of 7000 feet above sea level. *Access*, via the Union Pacific Railway and connections. *Hotel*, information as to accommodations is meagre, but presumably there are fairly good accommodations. The analysis shows the following mineralization:

LO LO HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Montana Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 13.00 |
| Sodium sulphate ($Na_2SO_4$) | 28.00 |
| Sodium bicarbonate ($NaHCO_3$) | 129.60 |
| Magnesium bicarbonate ($MgHCO_3$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 4.05 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 74.00 |
| Total solids | 248.65 |

The analysis shows a lightly mineralized, thermic, sodic, bicarbonated, sulphated and muriated, alkaline-saline water, possessing diuretic and antacid properties. The waters and hot baths are held in high esteem in the class of diseases for which this type of water is indicated.

### Pipestone Springs.

(*Jefferson County.*)

*Postoffice,* Pipestone. *Location,* in southwestern Montana; south of Helena, the capital city, 60 miles; west of Livingston, 90 miles; southeast of Butte, 30 miles; southeast of Anaconda, 50 miles. *Situation,* in the heart of the Rocky Mountains, at an elevation of 5000 feet above sea level. *Access,* via the Chicago, Burlington & Quincy and the Northern Pacific Railway connections. *Hotel,* there are very good hotel accommodations, with modern conveniences. Bathing establishment modern in construction and equipment. The analysis shows the following mineralization:

PIPESTONE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Montana Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 34.0 |
| Sodium sulphate ($Na_2SO_4$) | 156.0 |
| Sodium bicarbonate ($NaHCO_3$) | 123.2 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 5.5 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 20.0 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.6 |
| Silica ($SiO_2$) | 69.0 |
| Total solids | 408.3 |

Medicinal classification, weak total mineralization or (−T). The analysis shows this to be a moderately mineralized, thermic, sodic, sulphated, muriated and bicarbonated alkaline-saline water, possessing diuretic and antacid properties. The hot baths are efficacious in the treatment of rheumatic joint disturbances and the waters are also useful in the treatment of stomach, bowel, liver and kidney disorders.

### Warm Springs.

(*Deer Lodge County.*)

*Postoffice,* Warm Springs. *Location,* in southwestern Montana; southwest of Helena, the capital city, 55 miles; west of Boulder, 40 miles; northwest of Butte, 20 miles. *Situation,* in the great Rocky Mountains, at an elevation of 7000 feet above sea level. *Access,* via the Northern Pacific Railway and the Chicago, Burlington & Quincy Railway and connections. *Hotel,* there is a modern resort hostelry,

with ample accommodations. The bathing establishement is modern in construction and equipment, and all branches of hydrotherapy and balneotherapy are under the supervision of a competent resident physician. The analysis below shows the mineralization:

WARM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Montana Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 10.20 |
| Sodium sulphate ($Na_2SO_4$) | 397.00 |
| Calcium sulphate ($CaSO_4$) | 585.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 122.74 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 199.26 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 3.00 |
| Silica ($SiO_2$) | 53.00 |
| Total solids | 1270.20 |

Medicinal classification, weak calcic sulphate 2 or (−CaS2). The analysis shows this to be a moderately highly mineralized, thermic, sodic and calcic, sulphated, bicarbonated, alkaline-saline water, possessing diuretic, antacid, slight laxative and tonic properties. The Warm Springs baths have quite a reputation in the treatment of chronic rheumatic and arthritic disorders and in chronic skin affections. The water cure has given results in gastro-intestinal affections, diseases of the liver, bladder and kidney diseases.

### White Sulphur Springs (Hot Springs).

(*Meagher County.*)

*Postoffice*, White Sulphur Springs. *Location*, west of the center of the state; east of Helena, the capital city, 55 miles; north of the celebrated Yellowstone National Park, 125 miles. *Situation*, in the upper valley of the Smith River, a wild mountain stream rushing along to join the upper waters of the Missouri River. The springs rise at the foothills of the Elk Mountains, and are all located in the town of White Sulphur Springs; the elevation, 5280 feet above sea level. The scenery is beautifully picturesque, the various mountain ranges forming a natural panorama of great charm and beauty. The climate is much milder than the elevation and latitude would suggest. *Access*, the town is on a branch line of the White Sulphur Springs & Yellowstone Park Railroad, connecting with the Chicago, Milwaukee & St. Paul Railway, 23 miles distant. The great national highways afford access by motor, through a beautifully picturesque mountainous country. *Hotel*, the springs do not at present maintain hotel accommodations, but a contemplated modern hotel and bathing establishment will be erected in 1927 in the town of White Sulphur Springs, only a short distance from the springs, are several modern hostelries. There

is a modern bathing establishment not far from the springs, equipped with the latest appurtenances for the scientific application of the latest knowledge of hydrotherapy and balneotherapy, supervised by a competent physician and a corps of trained assistants. Here every form of baths and rubs are administered for the relief of rheumatism and arthritic joint affections. There are a number of springs in the area, but the analyses vary so little that only one is given herewith, Spring No. 1, the largest flowing and most used. The analysis below shows the mineralization:

WHITE SULPHUR SPRINGS (HOT SPRINGS).

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. M. Cobleigh). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Sodium chloride (NaCl) | 304.0 |
| Sodium sulphate ($Na_2SO_4$) | 445.0 |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium nitrite ($NaNO_2$) | none |
| Sodium bicarbonate ($NaHCO_3$) | 876.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 72.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 182.0 |
| Ferric oxide and Alumina ($Fe_2O_3$, $Al_2O_3$) | 4.0 |
| Silica ($SiO_2$) | 44.0 |
| Total solids | 1927.0 |

Medicinal classification, weak alkaline a3, weak sulphated or (−Aa3, −S), sulphuretted. An examination of this analysis shows this to be a moderately highly mineralized, thermic, sodic, muriated, sulphated, bicarbonated, alkaline-saline water, sulphuretted. The predominating chemical constituents are bicarbonates, sodium, magnesium and calcium, which exert antacid effects; the sodium sulphate element exerts slight laxative action and the sodium chloride produces slight aperient action. The water, therefore, possesses diuretic, antacid, slight laxative and tonic action. It has been used with success in the treatment of rheumatism, skin affections and in gastric disturbance due to hyperacidity. The hot baths are particularly helpful in the treatment of rheumatic and arthritic disorders, and in some forms of skin disease.

The following springs were once used as resorts:

*Allan's Mineral Spring, P. O.*, Pine Creek, Missoula County. This spring is located in the Bitter Root Valley, but no definite information nor satisfactory analysis available.

*Puller Springs, P. O.*, Puller, Madison County. This spring is located in a beautiful valley, at an elevation of 5530 feet above sea level. There are 2 springs, both thermic. No definite information nor satisfactory analysis available.

The following spring reported the sale of water in 1924:

*Lissner Mineral Springs, P. O.*, Helena, Lewis and Clark County.

## NEBRASKA.

Nebraska extends from 40° to 43° north latitude and from 95°13′ to 104° west longitude, and comprises an area of 77,510 square miles, of which 670 square miles are under water. The greater part of the state may be termed a great plateau. The eastern part of the state has an elevation of 2500 feet above sea level. In the extreme western part of the state, where the foothills of the Rocky Mountains begin, the elevation rises to 5038 feet. There are a great number of ponds and small lakes throughout the plateau region. Owing to the elevation above the sea, the dryness of the atmosphere, and the great amount of ozone which it contains, and the splendid drainage of the state, the climate is exceptionally healthy. The mean annual temperature, as observed at Omaha, is 9° C. (49.28° F.); that of the summer, 24° C. (74.26° F.); that of the winter, 5.6° C. (23.36° F.). The extremes are very great, the mercury sometimes falling to −41.1° C. (42° F. below zero), and at times rising to 45.6° C. (114° F. above).

Nebraska has 3 spring localities, with a total of 3 individual mineral springs (Peale). None of the older works mention any resorts in the state, Crook lists 1 and Peale says springs of any sort are of infrequent occurrence. Therefore the mineral springs of Nebraska are few in number and so far of little or no importance.

*Victoria Mineral Springs, P. O.*, New Helena, Custer County. There are said to be 7 springs in this area, located 2600 feet above sea level. The springs are said to have been first discovered in 1888, and each one contains a different variety of water. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

The following spring reported the sale of water in 1924:

*Curo Mineral Springs, P. O.*, Omaha, Douglas County.

## NEVADA.

Nevada extends from 35° to 42° north latitude and from 114° to 120° west longitude, and comprises an area of 110,700 square miles, of which 690 square miles are covered with water. The state has an extreme length from north to south of 483 miles, and an extreme breadth of 320 miles. The surface of the state is an immense table-land, with an elevation of over 4000 feet above sea level, broken into by several ranges of mountains, running from north to south. The Sierra Nevada Mountains form a part of the western boundary and vary from 7000 to 13,000 feet in height. There are several large lakes within the state. Pyramid Lake is 35 miles long and 10 miles wide and Lake Tahoe is 21 miles long and 11 miles wide, both being more than 6000 feet above sea level. The climate is generally dry and healthful, the mean annual temperature is 13°C. (54. 13° F.); of the summer, 24° C. (75.18° F.); of the winter, 1.2° C. (34.55° F.). The

maximum may rise to 43.3° C. (110° F.), and the minimum is about 1.1° C. (30° F. below zero).

Nevada has 120 spring localities, with a total of 179 individual springs (Peale), 4 of which have been analyzed, and at various times 10 have been used as resorts. The state is plentifully supplied with mineral springs of great variety; but few are well known. None are mentioned as resorts in the older works, Crook mentions only 1, although Peale lists 10. The majority of the springs are thermic, and they are found mainly in the western and more mountainous portion of the state. There are a number of localities where carburetted, carbonated, alkaline-saline, chalybeate and calcic waters abound. Few analyses have been made, but 1 spring closely resembles the celebrated Apollinaris Spring of Prussia. A number of localities have been improved, and several have had some reputation for the curative effects of their waters. The present list has been obtained from the literature and from correspondence with spring owners and largely through the courtesy of Mr. Danford C. Dinsmore of the State Geological Survey.

### Bower's Mansion Springs.

(*Wahoe County.*)

*Postoffice,* Franktown. *Location,* in western Nevada; north of Carson City, the capital city, 10 miles; west of Virginia City, 10 miles; south of Reno, 26 miles. *Situation,* in the heart of the Sierra Nevada Mountains, at an elevation of 7000 feet above sea level. *Access,* via the Southern Pacific Railway System. *Hotel,* there is a typical western resort hostelry. The analysis below shows the mineralization:

BOWER'S MANSION SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Nevada State Geological Survey). . |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 10.80 |
| Sodium chloride (NaCl) | 4.40 |
| Sodium sulphate ($Na_2SO_4$) | 55.70 |
| Sodium bicarbonate ($NaHCO_3$) | 65.61 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 26.93 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 16.20 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 44.00 |
| Total solids | 223.64 |

The analysis shows this to be a lightly mineralized, thermic, sodic, sulphated, bicarbonated, muriated alkaline-saline water, possessing diuretic and antacid properties.

### Elko Natatorium Springs.

(*Elko County.*)

*Postoffice,* Elko. *Location,* in northeastern Nevada; west of the Great Salt Lake Desert in Nevada, 100 miles; east of Wumemucca,

100 miles. *Situation*, in the valley of the Hennebolt River, at an elevation of 6000 feet above sea level. *Access*, on the main line of the Southern Pacific Railway, thence only a short distance to the springs. *Hotel*, there is a modern building with hotel conveniences. The bathing department is modern in appointment and equipment. The analysis below shows the mineralization:

ELKO NATATORIUM SPRINGS.

| Hypothetical combinations. | Parts per 1,00,0000 (Analyst, Nevada Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 56.0 |
| Sodium sulphate ($Na_2SO_4$) | 122.0 |
| Sodium bicarbonate ($NaHCO_3$) | 364.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 90.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 218.7 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 70.0 |
| Total solids | 921.0 |
| Temperature, °C. | 65.6 |

Medicinal classification, weak alkaline a2 or (−Aa2), thermic. The analysis shows this to be a moderately mineralized, thermic, sodic, calcic bicarbonated, sulphated alkaline-saline water, possessing diuretic and antacid properties. This water has attained some prominence in stomach disorders and bladder and kidney affections.

## Lawton's Springs.

(*Washoe County.*)

*Postoffice*, Reno. *Location*, in western Nevada; north of Carson City, the capital city, 20 miles; west of Wadsworth, 30 miles. *Situation*, in the Sierra Nevada Mountains, at an elevation of about 7000 feet above sea level. *Access*, via the Southern Pacific Railway. *Hotel*, there are a number of good hotels, with modern conveniences. The analysis below shows the mineralization:

LAWTON'S SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Nevada Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 112.05 |
| Sodium sulphate ($Na_2SO_4$) | 202.64 |
| Sodium borate ($Na_2B_4O_7$) | 9.32 |
| Sodium bicarbonate ($NaHCO_3$) | 37.27 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 4.97 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 27.53 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.50 |
| Silica ($SiO_2$) | 46.00 |
| Total solids | 441.28 |
| Temperature, °C. | 50 |

Medicinal classification, weak total mineralization or (−T), thermic. The analysis shows this to be a moderately mineralized, thermic, sodic, sulphated and muriated saline water, possessing diuretic and very slight laxative properties.

### Shaw's Hot Springs.

*(Ormsby County.)*

*Postoffice*, Carson City. *Location*, in western Nevada; east of Lake Tahoe, two-thirds of which lie in the state of California, 5 miles; south of Reno, 30 miles; north of Douglas, 10 miles. *Situation*, in the heart of the Sierra Nevada Mountains, at an elevation of 7000 feet above sea level. *Access*, via the Southern Pacific Railway System to Carson City, thence over macadamized mountain highways, through a picturesque mountainous region, 2 miles northeast to the springs. *Hotel*, there are good accommodations, with modern conveniences. The bathing facilities are modern in appointment and equipment. The analysis shows the mineralization:

SHAW'S HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Nevada Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 46.00 |
| Sodium sulphate ($Na_2SO_4$) | 54.00 |
| Calcium sulphate ($CaSO_4$) | 37.00 |
| Sodium bicarbonate ($NaHCO_3$) | 183.62 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 16.20 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.30 |
| Silica ($SiO_2$) | 44.00 |
| Total solids | 380.12 |

Medicinal classification, weak total mineralization or (−T). The analysis shows this to be a moderately mineralized thermic, sodic bicarbonated, sulphated, muriated, alkaline-saline water, possessing diuretic and antacid properties. This was formerly known as Swift's Spring.

### Steamboat Springs.

*(Washoe County.)*

*Postoffice*, Steamboat. *Location*, in the western Nevada; east of the California boundary line, 12 miles; north of Carson City, the capital city, 20 miles; south of Reno, 12 miles; west of Virginia City, 10 miles; north of Lake Tahoe, lying two-thirds in California and one-third in Nevada, 10 miles. *Situation*, in a wild, weird mountainous region of the Sierra Nevada Range, at an elevation of 6500 feet above sea level, some of the surrounding peaks reaching an altitude of from

7000 to 9000 feet. *Access*, via the Southern Pacific Railway and the San Pedro, Los Angeles & Salt Lake Railways. *Hotel*, there are comfortable hotel accommodations. The analysis below shows the mineralization:

STEAMBOAT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Nevada Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 1574.0 |
| Sodium sulphate ($Na_2SO_4$) | 190.0 |
| Magnesium sulphate ($MgSO_4$) | 45.0 |
| Calcium sulphate ($CaSO_4$) | 102.0 |
| Sodium bicarbonate ($NaHCO_3$) | 382.2 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 332.0 |
| Total solids | 2625.2 |
| Temperature, °C. | 95.6 |

Medicinal classification, weak alkaline a, weak saline 4 or (−Aa4, −Cl 4), thermic. The analysis shows a moderately highly mineralized, thermic, sodic, muriated, bicarbonated and sulphated, saline water, possessing diuretic, antacid and slight aperient properties. This is a highly muriated sodic water, carrying NaCl, 1574 parts per 1,000,000.

## Walley's Hot Springs.

(*Douglass County.*)

*Postoffice*, Gardnerville. *Location*, in extreme western Nevada; east of southern border of Lake Tahoe in the state of California, 9 miles; south of Reno, 47 miles; south of Virginia City, 27 miles. *Situation*, in the beautifully picturesque Carson Valley, at an altitude of 6000 feet above sea level. *Access*, via the Southern Pacific Railway from Truckee to Minden, thence by auto stage a short distance to the springs. *Hotel*, there is a comforable resort hostelry, with modern conveniences. The bathing establishment is of stone construction and has all conveniences for administering natural hot-water baths. The water on analysis shows the following mineralization:

WALLEY'S HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, N. Wilson). |
|---|---|
| Sodium chloride ($NaCl$) | 75.91 |
| Sodium sulphate ($Na_2SO_4$) | 233.93 |
| Sodium bicarbonate ($NaHCO_3$) | 142.17 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 16.67 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 75.64 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 5.59 |
| Silica ($SiO_2$) | 61.45 |
| Total solids | 611.36 |
| Temperature, °C. | 90 |

Radio-activity high.

Medicinal classification, weak total mineralization 2 (−T2), thermic. The analysis shows a moderately mineralized, thermic, sodic sulphated and bicarbonated alkaline-saline water, radio-activated, possessing diuretic, antacid and tonic properties. The hot baths have been used with great success in rheumatic conditions, arthritis and in chronic skin diseases. The high radio-activity of the water adds to its therapeutic potency for both internal and external administration.

The following springs were used as resorts by the Aborigines and later by the white settlers:

*Golconda Hot Springs*, Golconda, Humboldt County. No definite information nor satisfactory analysis available.

*Kyle's Hot Springs, P. O.*, Star Peak, Humboldt County. No definite information nor satisfactory analysis available.

*Sulphur Springs, P. O.*, Sodaville, Esmeralda County. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

The following spring reported the sale of water in 1924:

*Diamond Mineral Spring, P. O.*, Reno, Washoe County.

## NEW HAMPSHIRE.

New Hampshire extends from 43°41′ to 45°11′ north latitude, and from 70°40′ to 72°28′ west longitude, and comprises an area of 9305 square miles, of which 300 square miles are under water; the extreme length of the state is 178 miles and the extreme breadth is 88 miles. The state is relatively rough and mountainous. The eastern spurs of the Appalachian Mountains traverse the state lengthwise, culminating in a range known as the White Mountains, the highest peak, Mount Washington, reaching an altitude of 6293 feet above sea level. Like all glaciated areas, New Hampshire abounds in lakes. The largest is Lake Winnepesaukee, 16 miles long and 6 miles wide. The long narrow basins, surrounded by steep, rugged and, in many sections, lofty mountains present a weird grandeur of scenery, unsurpassed in any state in the Union. The climate is healthful; the winters, however, are long and cold and the summers short and frequently hot. The temperature for January is about 6.7° C. (20° F.); for July, around 21.1° C. (70° F.). The climate is quite humid in summer, and in midwinter the mercury falls considerably below zero.

New Hampshire has 12 spring localities, with a total of 27 individual springs, of which 8 have been analyzed, and at various times 8 have been used as resorts. While the state has several mineral springs, with one or two exceptions, none of them appear to have become very popular as resorts. The waters of the commercial springs have not enjoyed a very large sale, only 3 reporting sales in 1923. Of the older writers on mineral springs, Walton gives 4 localities, Crook mentions 3 and Peale about the same number. The waters are not

highly mineralized, and chalybeate waters seem to predominate. The following list has been secured mainly from correspondence with spring owners.

### Brunswick Mineral Springs.

*(Coos County.)*

*Postoffice*, North Stratford. *Location*, in northern New Hampshire; west of Maine-New Hampshire boundary line, 30 miles; north of Concord, the capital city, 100 miles. *Situation*, in the beautiful valley of the Connecticut River, at an elevation of about 5000 feet above sea level. The scenery is unsurpassed in any section of the New England States. *Access*, via Canadian National and Maine Central Railways, thence $1\frac{1}{2}$ miles to the springs. *Hotel*, there are ample and commodious hotel accommodations. There is also a bathing establishment, modern in construction and equipment. There are 6 springs in this area. The mineralization is shown in the following analysis:

BRUNSWICK MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, New Hampshire Board of Health).[1] | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 5. | Spring No. 6. |
| Sodium chloride ($NaCl$) | 0.80 | 0.70 | 0.70 | 0.70 | 0.80 | 0.80 |
| Sodium sulphate ($Na_2SO_4$) | 7.40 | 6.00 | 7.10 | 6.00 | 6.50 | 6.50 |
| Sodium bicarbonate ($NaHCO_3$) | 6.50 | 16.30 | 11.30 | 16.70 | 13.10 | 10.70 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 3.30 | 2.20 | 2.60 | 1.80 | 2.20 | 1.50 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 9.60 | 11.60 | 11.60 | 9.90 | 8.10 | 9.30 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.13 | 0.78 | 1.67 | 1.11 | 0.33 | 1.56 |
| Aluminum oxide ($Al_2O_3$) | 0.50 | 3.00 | 3.10 | 3.10 | 2.70 | 2.50 |
| Silica ($SiO_2$) | 2.80 | 2.80 | 3.60 | 3.60 | 4.00 | 4.40 |
| Total solids | 31.00 | 43.48 | 41.67 | 42.81 | 37.73 | 37.26 |
| Gases: | | | | | | |
| Sulphuretted hydrogen | ... | ... | ... | traces | ... | ... |

[1] Analyses made from laboratory sample: no examination at spring.

The analyses of these springs show such a close similarity of the percentage of the predominating chemical constituents and amount of total solids that they may be classed as slightly mineralized, sodic sulphated and bicarbonated alkaline-saline waters; Spring No. 4, slightly sulphuretted. These waters possess diuretic, antacid and slight tonic properties, due to the iron bicarbonate. This type of water is useful wherever a pure potable water is indicated. In gastric indigestion due to acidity and in bladder and kidney irritations, the iron content in all the springs, except No. 1, is such as to impart valuable tonic properties in anemia, chlorosis, etc.

## Granite State Spring.

(*Rockingham County.*)

*Postoffice,* Atkinson Depot. *Location,* in the extreme southeastern corner of the state; southeast of Portsmouth, 30 miles; northeast of Nashua, 15 miles. *Situation,* in rolling, gently undulating section of country, south of the lake and mountain region. *Access,* via Atkinson Depot, Grand Trunk Railway System and connections; distance to the springs, 1½ miles. *Hotels,* no accommodations for guests. The analyses given herewith show the mineralization:

GRANITE STATE SPRING.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, A. D. Little.) Spring No. 1. | (Analyst, W. W. Skinner.) Spring No. 2. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | ... | 0.006 |
| Potassium chloride (KCl) | ... | 2.760 |
| Sodium chloride (NaCl) | 7.4 | 5.960 |
| Magnesium chloride ($MgCl_2$) | 4.5 | |
| Sodium sulphate ($Na_2SO_4$) | ... | 5.640 |
| Calcium sulphate ($CaSO_4$) | 9.3 | |
| Sodium nitrate ($NaNO_3$) | 3.6 | 9.550 |
| Sodium bicarbonate ($NaHCO_3$) | ... | 2.110 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1.7 | 11.780 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 12.8 | 38.120 |
| Ferric oxide and alumina ($Fe_2O_3$ and $Al_2O_3$) | 4.0 | 0.550 |
| Silica ($SiO_2$) | 14.1 | 15.180 |
| Organic and volatile matter | 4.3 | |
| Total solids | 61.7 | 91.565 |
| Gases, cc. per liter, at 0° C. and 760 mm. pressure: | | |
| Carbon dioxide (free) | ... | 0.4 |
| Carbon dioxide set free from bicarbonates on evaporation | ... | 7.4 |
| Hydrogen sulphide | ... | none |

Spring No. 1, the chemical analysis shows a slightly mineralized, calcic, sodic bicarbonated alkaline water, carbon-dioxated, possessing antacid and diuretic properties.

Spring No. 2, the chemical analysis shows a lightly mineralized, calcic, sodic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic and antacid properties. Both of the springs, on analysis, show quite a similarity in their predominating chemical constituents; they are both sanitarily pure and are most excellent potable waters.

## Lafayette Spring.

(*Rockingham County.*)

*Postoffice,* Derry. *Location,* in southeastern New Hampshire; southeast of Concord, the capital city, 25 miles; northeast of Nashua, 12

miles. *Situation*, in a gently undulating region, about 80 feet above sea level, south of the lake and mountain region. *Access*, via Grand Trunk Railway System and connections. *Hotel*, not a resort, but hotel accommodations in Derry. The analysis below shows the mineralization:

LAFAYETTE SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. R. Angel; recalculated by W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.06 |
| Potassium chloride (KCl) | 5.56 |
| Sodium chloride (NaCl) | 0.20 |
| Sodium sulphate ($Na_2SO_4$) | 21.20 |
| Sodium nitrate ($NaNO_3$) | 0.43 |
| Sodium bicarbonate ($NaHCO_3$) | 7.70 |
| Magnesium bicarbonate ($MgHCO_3$) | 12.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 71.70 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.43 |
| Calcium silicate ($CaSiO_3$) | 4.60 |
| Silica ($SiO_2$) | 18.00 |
| Total solids | 141.88 |
| Gases: | |
| Carbon dioxide (free) | 2.9 |
| Carbon dioxide set free on evaporation | 12.8 |
| Temperature, °C. | 7.8 |
| Flow in gallons per day | 4320 |

The analysis shows this to be a lightly mineralized, calcic, sodic, magnesic bicarbonated alkaline water, slightly carbon-dioxated, possessing diuretic and antacid properties. Approximately 63 per cent of the total solids are present as the bicarbonates of sodium, magnesium and calcium, and 15 per cent as the sodium sulphate. This water should be of service in the treatment of gastric disorders due to acidity, and when taken on an empty stomach before breakfast the sodium sulphate may exert slight stimulating effect on the bowels.

## Londonderry Spring.

(*Richmond County.*)

*Postoffice*, Londonderry. *Location*, in the southeastern portion of the state; northeast of Nashua, 15 miles; southeast of Concord, the capital city, about 25 miles; south of Manchester, 8 miles. *Situation*, in a beautiful rolling region, south of the White Mountains, and of the celebrated Winnepesaukee Lake. *Access*, via Londonderry Depot, and by motor, over graded macadam highways from Boston; the White Mountains and the lake resorts of Maine. *Hotel*, no accommodations for guests, as the spring is not used as a resort. The following analysis shows the mineralization:

LONDONDERRY SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.038 |
| Lithium chloride ($LiCl$) | trace |
| Sodium chloride ($NaCl$) | 2.270 |
| Potassium chloride ($KCl$) | 1.900 |
| Sodium sulphate ($Na_2SO_4$) | 8.200 |
| Magnesium sulphate ($MgSO_4$) | 3.620 |
| Sodium nitrate ($NaNO_3$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2.160 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 35.810 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.500 |
| Silica ($SiO_2$) | 14.040 |
| Total solids | 65.538 |
| Gases, at 0° C. and 760 mm. pressure: | |
| Carbon dioxide (free), cc. per liter | 5.7 |
| Carbon dioxide set free from bicarbonates upon evaporation | 5.3 |

This spring flows at the rate of 10 gallons per minute, with a temperature of 7.8° C. (46° F.). The chemical analysis shows this to be a slightly mineralized, calcic, bicarbonated alkaline (potassic) water, carbon-dioxated. Approximately 55 per cent of the total salts in solution are in the form of the bicarbonates of calcium and magnesium, with 12 per cent of the sulphate of sodium, and a smaller amount of sulphate of magnesium. This is a very valuable mineral water, possessing antacid, diuretic and ferruginous properties. Its use has been found beneficial in a wide range of diseases, gout, rheumatism, uric acid, calculi and in giddiness and headache from disorders of the stomach, etc.

## Mount Madison Spring.

(*Coos County.*)

*Postoffice*, Gorham. *Location*, in the eastern portion of the state; on the Androscoggin River, about 10 miles from the western boundary of the state of Maine, and lying near the northern slope of the White Mountains. *Situation*, in a beautifully picturesque mountain region, north of the foothills of Mount Washington, whose peaks reach 6293 feet above sea level. The spring is tucked away atop a picturesque plateau, with an elevation of 3000 feet, surrounded by a hilly, rolling country, presenting gorgeous scenic effects that reach away to the horizon. *Access*, via Gorham Station on the Boston & Maine Railway, thence a walk of 400 feet to the spring. *Hotel*, no accommodation for guests. The water on analysis reveals the following mineralization:

MOUNT MADISON SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, New Hampshire Board of Health). |
|---|---|
| Potassium chloride (KCl) | 1.50 |
| Potassium sulphate ($K_2SO_4$) | 7.80 |
| Sodium nitrate ($NaNO_3$) | 0.60 |
| Sodium sulphide ($Na_2SO_4$) | 1.90 |
| Sodium bicarbonate ($NaHCO_3$) | 9.30 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 11.30 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 38.90 |
| Ferric oxide ($Fe_2O_3$) | 0.07 |
| Alumina ($Al_2O_3$) | 0.60 |
| Silica ($SiO_2$) | 11.10 |
| Total solids | 83.07 |

This is a lightly mineralized, calcic, magnesic, sodic bicarbonated alkaline water, carbon-dioxated, flowing at the rate of 2400 gallons daily and possessing diuretic and tonic properties. Of use in mild irritations of the genito-urinary tract and in mild gastric acidity. The waters have been bottled and sold commercially for the past ten years, and enjoys a well-deserved local reputation.

The following springs were at one time used as places of resort:

*Amherst Soda Springs, P. O.*, Amherst, Hillsboro County. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked unknown and "out of business."

*Birchdale Springs, P. O.*, Concord, Merrimac County. There are 4 springs in this area, the Concord, the Merrimac, Granite and Penacook. We have been unable to obtain any definite information nor satisfactory analysis relative to the status of these springs. They were at one time used both commercially and as a resort. Postmaster returns correspondence marked "out of business."

*Bradford Mineral Springs, P. O.*, East Washington, Merrimac County. It is said that these springs first became known to the white settlers in 1770. At one time there was a good hotel for guests, but repeated correspondence failed to elicit any definite information nor secure satisfactory analysis. Postmaster returns correspondence marked "unknown."

*Moultonborough Mineral Springs, P. O.*, Moultonborough, Carroll County. Formerly this was a popular resort, but at the present time no definite information nor satisfactory analysis available.

*Ponemah Springs, P. O.*, Milford, Hillsboro County. There are 4 springs in this area. They have been used both commercially and as a resort, but no definite information nor satisfactory analysis available.

*White Mountain Mineral Springs, P. O.*, Conway, Carroll County. No definite information nor satisfactory analysis available.

The following spring reported the sale of water in 1924:

*Laconia Spring, P. O.*, Laconia, Belknap County.

## NEW JERSEY.

New Jersey extends from 38°56′ to 41°30′ north latitude and from 73°55′ to 75°32′ west longitude, and comprises an area of 7815 square miles, of which 290 square miles are under water. The extreme length of the state is 167 miles, and its greatest breadth is about 50 miles. The northern portion of the state is hilly and mountainous, the highest elevations ranging from 1000 to 1700 feet above sea level. The central portion of the state is a rolling savanna and the eastern portion is a sandy loam, in some localities only a 100 feet above sea level. The Palisades, a wall of perpendicular trap rock, from 300 to 600 feet high, form the western bank of the Hudson River for a distance of 15 miles from the mouth of the river. The state borders on the Atlantic Ocean, and has a coast line 120 miles long. Near the ocean the coast is fringed with salt marshes and shallow coast lagoons inclosed by outlying sandy beaches. The mean annual temperature, as observed at Newark during a period thirty years, was 10° C. (50.50° F.); that of the summer, 22° C. (70.30° F.); of the winter, 1.1° C. (30.75° F.).

New Jersey has 13 spring localities, with a total of 13 individual springs, 8 of which have been analyzed and 1 used as a resort (Peale). Walton mentions 2 localities and Crook gives 2. Schooleys Mountain Spring, near Hackensack, was conspicuous as a resort seventy-five years ago, but has long since been abandoned. Twenty-six springs reported the sale of water during the year 1925; they were principally potable waters sold in Jersey City and New York. Iron waters seem to predominate, but they are at present of comparatively little importance and little known. The list herewith has been secured mainly through correspondence with physicians and spring owners.

### Indian Springs.

*(Morris County.)*

*Postoffice,* Box 473, Rockaway. *Location,* in the upper northern section of the state; west of Jersey City, 30 miles; east of Dingman's Ferry, Pa., 31 miles. *Situation,* in a beautiful mountain region of the northern end of the state. *Access,* via the Lackawanna Railway to Rockaway Station and thence 2 miles to the springs; also via Central Railroad of New Jersey and the same distance via motor to the springs. *Hotel,* no accommodations for guests. The waters from Indian Springs show the following mineralization. This spring flows at the rate of 14,000 gallons daily:

INDIAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, T. B. Stillman). |
|---|---|
| Sodium chloride ($NaCl$) | 8.2 |
| Sodium sulphate ($Na_2SO_4$) | 9.2 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 7.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 27.2 |
| Ferric and alumina oxide ($Fe_2O_3$, $Al_2O_3$) | 0.9 |
| Silica ($SiO_2$) | 16.4 |
| Total solids | 69.6 |

This is a slightly mineralized, calcic, bicarbonated alkaline water, possessing diuretic properties. Physicians highly endorse the Indian Springs water as a safe, potable drinking water. The water is very popular, and has been bottled and shipped for the past twenty-five years. The bottling plant is modern and contains every safeguard for the sanitary handling of bottled waters.

The following springs were once used as resorts:

*Pine Grove Mineral Springs, P. O.*, Woodbury, Gloucester County. No definite information nor satisfactory analysis available.

*Pine Lawn Spring, P. O.*, Hohokus, Bergen County. No definite information nor satisfactory analysis available.

*Schooleys Mountain Spring, P. O.*, Schooleys Mountain, Morris County. This was once a very popular resort, located on a broad plateau on the northern part of New Jersey, 1200 feet above tide water and overlooking the Musconetcong Valley. The situation is near the celebrated Delaware Water Gap. The spring is ferruginous bicarbonated water. Postmaster returns correspondence marked "abandoned." We presume that this resort has been allowed to pass in innocuous desuetude for want of publicity.

The following springs reported the sale of water in 1924:

*Alpha Spring Water Co., P. O.*, Springfield, Union County.
*Belmar Spring, P. O.*, Ridewood, Bergen County.
*Cold Indian Spring, P. O.*, Asbury Park, Monmouth County.
*Culm Rock Springs Water Co., P. O.*, Somerville, Somerset County.
*Echo Spring, P. O.*, Trenton, Mercer County.
*Fairholme Springs, P. O.*, Wenonah, Gloucester County.
*Gray Rock Artesian Well, P. O.*, Trenton, Mercer County.
*Great Rock Spring, P. O.*, Whippany, Morris County.
*Indian Lady Hill Springs, P. O.*, Asbury Park, Monmouth County.
*Indian Spring, P. O.*, Rockaway, Morris County.
*Kalium Spring, P. O.*, Collingswood, Camden County.
*Kanouse Mountain Water Co., P. O.*, Oakland Spring, Bergen County.
*Linke Well, P. O.*, Plainfield, Union County.
*Manasquan Spring, P. O.*, Manasquan, Monmouth County.
*Mullin's Spring, P. O.*, Perth Amboy, Middlesex County.
*Pilgrim Spring, P. O.*, Ridgefield Park, Bergen County.
*Pine Crest Well, P. O.*, Chatsworth, Burlington County.
*Red Rock Spring, P. O.*, Hackensack, Bergen County.
*Rock Spring, P. O.*, West Orange, Essex County.
*Rosemont Spring, P. O.*, Somerville, Somerset County.
*Sanhioan Spring, P. O.*, Wilburtha, Mercer County.
*Turtle Hill Spring, P. O.*, Passaic, Passaic County.
*Washington Rock Spring, P. O.*, Plainfield, Somerset County.
*Watchung Springs, P. O.*, Plainfield, Somerset County.
*Xlo Water Well, P. O.*, Cedar Grove, Essex County.

## NEW MEXICO.

New Mexico extends from 31°20′ to 37° north latitude and from 103° to 109°9′ west longitude, and comprises an area of 122,580 square miles, of which 240 square miles are under water. The state is practically a series of elevated plateaus, covered with mountain ranges that often rise to high peaks. The state is 400 miles from north to south and 358 miles from east to west. The great Staked Plains is a waterless and treeless plateau, covering 44,000 square miles and at 5000 feet elevation. The Continental Divide runs across the state; its average elevation is 7000 feet and, as might be expected, it is a region of greatly diversified surface. New Mexico has wonderful picturesque scenery; some of the most romantic spots in the world is found amid its broken irregular mountain ranges, while on every side lie the ruins of ancient cities and dried-up canals, that speak mutely of a people whose history perished with them many thousands of years ago. The climate is dry and healthful, mild and equable; the winters cool and the summers invigorating. The mean annual temperature, as observed at Santa Fe, is 11° C. (50.54° F.); that of the summer, 22° C. (70.50° F.); of the winter, 1.1° C. (30.28° F.). The climate, while mild throughout the year, still in the northermost section the mercury often falls below zero.

New Mexico has 36 spring localities, with a total of 126 individual springs, of which 12 have been analyzed and 5 at one time or another have been used as resorts (Peale). As might be expected from the topography of the state, warm and hot spring predominate; they are principally of the alkaline and saline-calcic varieties. Many of the springs were in use years ago by the Franciscan and Dominican monks, and no doubt by the native Indians prior to the advent of the white man. Many of the hot springs still are popular throughout the southwest. The older writers on mineral springs fail to mention the springs in this region; Crook mentions 3 prominent places and Peale lists 12. From personal correspondence, the author has secured the following list, which is fairly representative of the localities in active use today.

### Carlsbad Springs.

*(Eddy County.)*

*Postoffice,* Carlsbad. *Location,* in southeastern New Mexico; north of the Texas state line, 35 miles; south of Roswell, 70 miles; east of Dona Ana, 175 miles. *Situation,* in the famous Pecos Valley, west of the Pecos River which joins the Rio Grande in western Texas. This place was formerly known as Eddy, but was changed to its present name on account of the supposed similarity of its mineral waters to those of Carlsbad in Austria. This section is noted for its delightful climate, dry bracing atmosphere and its valuable waters. *Access,* via

the Atchison, Topeka & Santa Fe Railway System to Carlsbad, thence by motor 2 miles to the springs. *Hotel*, accommodations at Carlsbad; modern conveniences. The analysis below shows the mineralization:

CARLSBAD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Gov. Otero's report, 1903). |
|---|---|
| Sodium chloride ($NaCl$) | 863.55 |
| Sodium sulphate ($Na_2SO_4$) | 752.74 |
| Magnesium sulphate ($MgSO_4$) | 369.60 |
| Calcium sulphate ($CaSO_4$) | 279.29 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 90.02 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 417.97 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 20.52 |
| Silica ($SiO_2$) | 20.52 |
| Total solids | 2814.21 |
| Flow in gallons per day | 7,920,000 |

Medicinal classification, weak saline 2, weak sulphated 4 or (−Cl 2, −S4). The analysis shows this to be a moderately highly mineralized, sodic, muriated and sulphated saline water, possessing diuretic, antacid, aperient and tonic properties. The striking difference between this water and the famous Carlsbad Springs is in the carbonate of calcium and magnesium chloride; the Austrian Spring is heavy in magnesium, with a small amount of calcium chloride, while this spring is destitute of magnesium chloride and heavy in calcium bicarbonate.

## Coyote Canyon Springs.

(*Bernalillo County.*)

*Postoffice*, Albuquerque. *Location*, near the center of the state of New Mexico; southwest of Santa Fe, the capital city, 65 miles; west of Puerto de Luna, 115 miles. *Situation*, at the southwestern base of the Sandia Mountains, at an elevation of about 6500 feet above sea level. *Access*, via the Atchison, Topeka & Santa Fe Railway to Albuquerque, thence by motor 17 miles to the spring. *Hotel*, accommodations, information meagre, but primitive conveniences obtainable. Three different areas in this canyon are noted for their mineral waters. On entering the canyon the first is the Harsch Springs, next are the original Coyote (Chaviz) Springs and the third is Top Hams (artesian well) Springs.

Iron Spring, medicinal classification, weak alkaline b4, weak saline 2, very weak ferruginous 0.5 or (−Ab4, −Cl 2, − −Fe 0.5).

Cotton Tail Spring, medicinal classification, weak alkaline b3, weak saline or (−Ab3, −Cl).

Coyote Spring, medicinal classification, weak alkaline b3, weak saline or (−Ab3, −Cl).

COYOTE CANYON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, New Mexico Agr. and Mechan. Arts). | | | |
|---|---|---|---|---|
| | Harsch Springs. | | Original Coyote Spring. | Top Hams Artesian Well. |
| | Iron Spring. | Cotton Tail Spring. | | |
| Sodium chloride (NaCl) | 676.00 | 533.40 | 586.00 | 191.00 |
| Potassium sulphate ($K_2SO_4$) | 83.30 | 50.30 | | |
| Sodium sulphate ($Na_2SO_4$) | 83.10 | 108.70 | 140.00 | 80.00 |
| Sodium bicarbonate ($NaHCO_3$) | 197.31 | 68.68 | 101.08 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 260.98 | 254.79 | 217.06 | 223.56 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 925.99 | 887.11 | 787.42 | 740.34 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 42.75 | 4.45 | | |
| Silica ($SiO_2$) | 71.86 | 6.84 | 12.40 | 23.94 |
| Total solids | 2341.29 | 1914.27 | 1863.96 | 1257.84 |

Artesian Well, medicinal classification, weak alkaline b3 or (−Ab3).

It will be observed from the percentage of the predominating chemical constituents of these waters that, perhaps, they all come from the same source and are practically the same water and may, for convenience, be classed as moderately, highly mineralized, calcic, magnesic and sodic bicarbonated, alkaline-saline water, possessing diuretic and antacid properties. The waters are said to be especially beneficial in gastric disorders and bladder and kidney troubles. The bottling plants at Top Hams Well and at Harsch Spring bottle and ship each about 25,000 gallons annually.

## Hot Springs.

*(Sierra County.)*

*Postoffice,* Hot Springs. *Location,* in the southwestern portion of the state; northeast of Fort Bayard, 60 miles; south of Albuquerque, 160 miles; north of El Paso, Tex., 165 miles. *Situation,* in the valley of the Rio Grande River, at an elevation of 4200 feet above sea level; 4 miles below is the famous Elephant Butte Dam, constructed by the U. S. Reclamation Service, making a lake 45 miles long and 8 miles wide, with a shore line of more than 200 miles, comprising the largest artificial reservoir in the world. *Access,* via Engel Station, on the Atchison, Topeka & Santa Fe Railway System, thence by motor 21 miles to the springs. *Hotels,* there are several modern hostelries, with every modern convenience. There are 2 modernly equipped bathing establishments, where every appurtenance has been installed for the scientific application of the latest knowledge in hydrotherapy and balneotherapy. There are 7 active springs in the area, all carrying practically the same percentage of the predominating chemical constituents.

HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Bureau of Chemistry, Washington). |
|---|---|
| Sodium chloride ($NaCl$) | 1771.60 |
| Potassium chloride ($KCl$) | 131.40 |
| Potassium nitrate ($KNO_3$) | 0.80 |
| Calcium chloride ($CaCl_2$) | 143.90 |
| Calcium sulphate ($CaSO_4$) | 113.00 |
| Magnesium sulphate ($MgSO_4$) | 63.10 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 278.60 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.60 |
| Aluminum oxide ($Al_2O_3$) | 3.20 |
| Silica ($SiO_2$) | 43.00 |
| Total solids | 2549.20 |
| Temperature, °C. | 46.7 |
| Flow in gallons per day | 48,000 |

Medicinal classification, saline or (Cl), thermic. The analysis shows a moderately highly mineralized, thermic, sodic, muriated, saline water, possessing eliminative and tonic properties. The waters have been found highly efficient in the relief of chronic joint affections, rheumatism, neuritis and chronic run-down conditions generally. This spring was formerly known as Palomas Hot Springs, and has been referred to as the American Carlsbad. The waters and hot baths given here have a reputation for speedy relief in chronic skin diseases.

## Jemez Hot Springs.

(*Sandoval County.*)

*Postoffice*, Jemez Springs. *Location*, a little to the north of the center of the state; west of Santa Fe, the capital city, 45 miles; north of Albuquerque, 60 miles; in the region known as the Jemez Plateau. *Situation*, in the Jemez River Bed, San Diego Canyon, at an elevation of 6620 feet above sea level, rise the Jemez Hot Springs. This beautifully picturesque canyon is surrounded by the Jemez Mountains, rough, rugged and primeval, full of scientific interest and charm. *Access*, via Atcheson, Topeka & Santa Fe Railway Company to Albuquerque, thence via motor 60 miles to the springs, over wonderful mountainous highways and through a charming picturesque mountain scenery of great charm and beauty. *Hotel*, there are excellent accommodations. The bathing equipment includes a bath-house, where the natural hot waters are used for curative purposes. The Jemez Hot Springs hotels and bathing establishment are open from April 1 to November 15. The pleasing feature of the protected canyon makes for mild winters and cool summers, an exceedingly delightful combinations of climatic advantages. The springs of the Jemez Plateau are found mainly in the southern portion of this tableland or mesa. The Jemez Hot Springs comprise about 40 in Group I, and 2 miles south

is another group of 10 or more. At each group have been built comfortable bath-houses and steam rooms. The waters range from 48° to 68° C. (120° to 155° F.), and have a mineral content of 2100 to 3700 parts per 1,000,000 total solids, mostly sodium chloride and sodium bicarbonate. The following analysis shows the mineralization of 4 of the Jemez Hot Springs:

JEMEZ HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analyst, J. D. Clark. | Analyst, New Mexico School of Mines. | | |
| | Spring No. 1 | Spring No. 3 | Geyser Spring. | Upper Group Spring. |
| Lithium chloride (LiCl) | ... | trace | trace | trace |
| Potassium chloride (KCl) | 137.1 | trace | trace | trace |
| Sodium chloride (NaCl) | 1178.1 | 1508.0 | 1622.0 | 2642.0 |
| Sodium sulphate ($Na_2SO_4$) | 91.1 | ... | 35.0 | 59.0 |
| Calcium sulphate ($CaSO_4$) | ... | 262.0 | trace | |
| Sodium bicarbonate ($NaHCO_3$) | 166.6 | ... | ... | 374.7 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 36.7 | 388.8 | 166.8 | 91.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 467.6 | 486.0 | 1038.4 | 887.7 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 6.0 | | | |
| Calcium silicate ($CaSiO_3$) | 61.6 | | | |
| Silica ($SiO_2$) | 50.9 | 10.0 | ... | 201.0 |
| Total solids | 2195.7 | 2679.0 | 2862.2 | 3255.7 |
| Temperature, 0°C. | 75.5 | 38.9 | 42.5 | 41.1 |

Spring No. 1, medicinal classification, weak alkaline b2, weak saline 3 or (−Ab2, −Cl 3), thermic. This is a moderately highly mineralized, thermic, sodic, muriated and bicarbonated, alkaline-saline (potassic) water, carbon-dioxated, possessing diuretic antacid and tonic properties. The waters are said to be of great value in the treatment of rheumatism, neuritis and sciatica, especially when complicated with renal disease.

Spring No. 3, medicinal classification, weak alkaline b2, weak saline 4 or (−Ab2, −Cl 4), thermic.

Geyser Spring, medicinal classification, weak alkaline b3, weak saline 4 or (−Ab3, −Cl 4), thermic.

Upper Group Spring, medicinal classification, weak alkaline b3, saline or (−Ab3, Cl), thermic.

These 3 springs are so nearly alike in amount of total solids and in the percentage of the predominating chemical constituents that they may with propriety be classed as moderately highly mineralized thermic, sodic, muriated and calcic, bicarbonated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid and aperient properties.

The region is one abounding in geological, historical and archaeological interest. The resort is at relatively low altitudes, where the weather is mild in winter, yet never hot in summer.

### Las Vegas Hot Springs.

*(San Miguel County.)*

*Postoffice,* Las Vegas. *Location,* in the northeastern New Mexico; east of Santa Fe, the capital city, 40 miles; northeast of Albuquerque, 90 miles. *Situation,* upon the southeastern slope of the Santa Fe Range of mountains, at an altitude of 6767 feet above sea level. Many archaeological relics, such as stone axes, pottery, flint and bone instruments have been found in the immediate vicinity of the springs and the ancient ruins nearby are mute evidence that the Europeans were not the first people to drink of and bathe in the water from these springs. *Access,* via the Santa Fe Railway to Las Vegas and via branch line 6 miles to the springs. *Hotel,* there is a modern resort hostelry, with modern appointments and conveniences. These springs are perhaps the most widely known in New Mexico. The bathing establishment is modern in construction and equipment; here every known type of bath is administered under the supervision of a resident physician. The mud baths and packs for swollen joints, due to gout and rheumatic affections, always prove beneficial. There are about 40 springs within a very circumscribed area, varying in temperature from very cold to 60° C. (140° F.). The analysis of the 5 more important is shown herewith:

LAS VEGAS HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | |
|---|---|---|---|---|---|
| | Analyst, New Mexico School of Mines. | | | | Analyst, Dr. W. S Haines. |
| | Hot Spring. | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 6. |
| Lithium chloride (LiCl) | ... | ... | ... | ... | trace |
| Sodium chloride (NaCl) | 64.10 | 272.60 | 243.70 | 273.40 | 251.02 |
| Sodium bromide (NaBr) | ... | ... | ... | ... | trace |
| Sodium sulphate ($Na_2SO_4$) | 52.60 | 141.20 | 159.30 | 162.70 | 57.28 |
| Potassium bicarbonate ($KHCO_3$) | trace | trace | trace | trace | 7.75 |
| Sodium bicarbonate ($NaHCO_3$) | 1944.00 | 27.86 | 18.95 | 81.00 | 232.34 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 137.10 | 98.06 | 114.54 | 123.24 | 4.15 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 68.55 | 49.03 | 57.27 | 61.62 | 24.15 |
| Silica ($SiO_2$) | trace | 10.40 | trace | 24.10 | 59.85 |
| Total solids | 2266.35 | 599.15 | 593.76 | 726.06 | 673.04 |
| Temperature, °C. | 62 | 24.4 | 32 | 43 | 60 |
| Flow in gallons per day | ... | ... | ... | ... | 28,000 |

Hot Spring, medicinal classification, alkaline a or (Aa), thermic. The analysis shows this to be a moderately highly mineralized, sodic, bicarbonated alkaline water.

Spring No. 1, medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, sodic, muriated and sulphated saline water.

Spring No. 2, medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, sodic, muriated sulphated saline water.

Spring No. 3, medicinal classification, weak total mineralization 2 or (−T2), thermic. This is a moderately mineralized, sodic, muriated and sulphated saline water.

Spring No. 6, medicinal classification, weak total mineralization 2 or (−T2), thermic. This is a moderately mineralized, sodic muriated and bicarbonated alkaline-saline water. The water from the Hot Spring possesses diuretic, antacid and alterative properties, and has attained quite a reputation in the treatment of disorders of the intestinal tract due to stasis and poisons resulting therefrom. The rest of the springs are quite similar in the percentage of their predominating chemical constituents and possess similar therapeutic properties, diuretic, antacid and alterative action and are of use in the treatment of stomach, bladder and kidney affections. The hot baths are efficacious in all rheumatic affections, chronic joint disturbance and chronic affections of the skin and lymphatic system.

## Ojo Caliente Hot Springs.

(*Taos County.*)

*Postoffice*, Ojo Caliente. *Location*, in the northern part of the state; north of Santa Fe, the capital city, 50 miles; east of the Navajo Indian Reservation, 150 miles; south of Colorado Springs, Colo., 220 miles; north of Albuquerque, 110 miles. *Situation*, in the upper section of the Jemez Plateau, in the valley of the Rio Grande, and on the west bank of the river of the same name. The mesa in which the springs are located has an elevation of 6800 feet above sea level. This locality was the former home of the ancient cliff dwellers. Some of the most ancient ruins of the southwest are found in this valley and on the contiguous mesas to these springs. A later and more extensive city of the Pueblos is in evidence from the ruins found on the mesa on the west side of the valley and about ½ mile south of the spring. This Pueblo seems to be the phoenix which has risen from the débris of a still older city; thus the history of those primitive people exists only in the fragmentary ruins that have defied the elements to the present time. *Access*, via Baranca Station, on the Denver & Rio Grande Railway, thence by motor 12 miles, over picturesque mountain highways, to the springs. *Hotel*, a comfortable and commodious modern

resort hostelry furnishes accommodations. The bathing establishment is modern in construction and equipment, offering facilities for the utilization of these natural thermal waters. The springs, about 20 in number, vary in temperature from 32.2° to 54.4° C. (90° to 130° F.). Four of these springs arise within a very small compass, and each one is peculiarly adapted for the treatment of a particular diseased condition. The following analyses, recalculated from original sources, show the mineralization.

OJO CALIENTE HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analyst, Oscar Lowe. | | Analyst, W. W. Clarke. | |
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Lithium chloride (LiCl) | ... | ... | ... | 20.90 |
| Potassium chloride (KCl) | ... | ... | ... | 59.90 |
| Sodium chloride (NaCl) | 380.30 | 379.80 | 400.30 | 305.50 |
| Potassium iodide (KI) | ... | ... | ... | trace |
| Sodium sulphate ($Na_2SO_4$) | 136.00 | 193.30 | ... | 223.30 |
| Potassium sulphate ($K_2SO_4$) | 51.70 | 53.40 | 52.90 | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | ... | ... | ... | 0.30 |
| Sodium nitrate ($NaNO_3$) | ... | ... | ... | trace |
| Sodium biborate ($Na_2B_4O_7$) | ... | ... | ... | 5.40 |
| Sodium diarsenate ($Na_2HAs_2O_3$) | ... | ... | 100.80 | |
| Calcium fluoride ($CaF_2$) | ... | ... | ... | 10.70 |
| Ammonium bicarbonate ($NH_4HCO_3$) | ... | ... | ... | trace |
| Sodium bicarbonate ($NaHCO_3$) | 3426.93 | 2820.80 | 3121.26 | 2936.57 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 107.78 | 93.85 | 106.18 | 57.69 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | ... | ... | 68.04 | 69.66 |
| Lithium bicarbonate ($LiHCO_3$) | 3.87 | 2.94 | 22.44 | |
| Barium bicarbonate ($Ba[HCO_3]_2$) | ... | ... | ... | trace |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | ... | ... | ... | 3.88 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | trace | ... | 308.74 | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | ... | ... | ... | 2.10 |
| Silica ($SiO_2$) | trace | trace | 40.00 | 60.20 |
| Total solids | 4106.68 | 3544.09 | 4120.64 | 3751.50 |
| Temperature ranges from 32.2° to 50° C. Combined flow, 300,000 gallons per day. | | | | |

Spring No. 1, medicinal classification, alkaline a2 or (Aa2), thermic. This is a moderately highly mineralized, sodic, bicarbonated, alkaline water, possessing diuretic and antacid properties.

Spring No. 2, medicinal classification, alkaline a1.5 or (Aa1.5), thermic. This is a moderately highly mineralized, sodic, bicarbonated, alkaline water. It is quite similar to Spring No. 1, both in its predominating chemical constituents and therapeutic properties.

Spring No. 3, medicinal classification, alkaline a1.5, very weak ferruginous 4 or (Aa1.5, ——Fe4), thermic. This is a moderately highly

mineralized, sodic and ferruginous bicarbonated alkaline (arseniated) water, possessing diuretic, antacid, tonic, reconstructive and alterative properties.

Spring No. 4, medicinal classification, alkaline a1.5 or (Aa1.5), thermic. This is a moderately highly mineralized, sodic, bicarbonated, alkaline (strontic) water, possessing antacid, diuretic, tonic and alterative properties.

This collection of medicinal waters takes rank with any of the celebrated springs of the United States and, perhaps, in the world. The presence of large quantities of sodium bicarbonate, besides the salts of lithium, barium, strontium, potassium, magnesium and iron, with a considerable percentage of carbonic-acid gas, give these waters a wide range of usefulness in the treatment of disease. The waters have been used successfully in the treatment of advanced syphilis, chronic induration of the lymphatic glands, gout, rheumatism and skin diseases.

Tradition points out the fact that the curative properties of these springs were known of by the aborigines of the Southwest long æons before the occupation of the country by the Spaniards. It is asserted that Cabaza de Vaca, the discoverer of Mexico, in 1534, visited and named these springs Ojo Caliente, which appellation they have ever borne. Many superstitious traditions exist in the neighboring tribes today concerning their curative properties. Some fifty years after the expedition of Coronda a fatal blood disease spread among the Pueblo Indians, with such a high mortality that the Spanish priests erected a church on the plaza, just east of the springs, to provide spiritual comfort for the poor unfortunate sufferers. No doubt this great affliction wrought on the simple Pueblos was due to the Spanish soldiers, who tainted the blood of the aborigines at the time of the Coronda. This ancient church is still standing in a fairly good state of preservation. As near as can be determined, the first Americans came here in 1810.

### Quelites Mineral Springs.

*(Valencia County.)*

*Postoffice,* Quelites. *Location,* in western New Mexico; west of Albuquerque, 50 miles; southwest of Santa Fe, the capital city, 100 miles; north of Socoro, 80 miles. *Situation,* 2 miles above the old Mexican village of Quelites, on the Antonia Sidillo Grant, on the northeast side of the San Jose River and in the valley of same. The springs lie at the foot of some bluffs of massive cretaceous sandstone, at an elevation of 7000 feet above sea level; to the north is the Continental Divide, and within a short distance of Mt. Taylor, whose pinnacle pierces the clouds to an altitude of 11,380 feet. *Access,* via the Atchison, Topeka & Santa Fe Railway. *Hotel,* primitive accommodations. The analysis herewith shows the mineralization:

QUELITES MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. W. F. James). |
|---|---|
| Lithium chloride (LiCl) | 5.27 |
| Potassium chloride (KCl) | 282.63 |
| Sodium chloride (NaCl) | 13,134.35 |
| Sodium bromide (NaBr) | 1.87 |
| Sodium iodide (NaI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 9,602.55 |
| Magnesium sulphate ($MgSO_4$) | 972.93 |
| Barium sulphate ($BaSO_4$) | trace |
| Sodium borate ($Na_2B_4O_7$) | 9.63 |
| Sodium phosphate ($Na_2HPO_4$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 378.50 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 3,836.83 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 65.79 |
| Aluminum oxide ($Al_2O_3$) | 11.93 |
| Silica ($SiO_2$) | 31.92 |
| Total solids | 28,333.90 |

Medicinal classification, alkaline b2, strong saline 1.3, strong sulphate or (Ab2, +Cl 1.3, +S). The analysis shows this to be a very highly mineralized, thermic, sodic, muriated, sulphated and sodic and calcic bicarbonated saline (bromic, ferruginous) water, possessing diuretic, antacid, aperient, tonic and alterative properties. The waters have long been used with success in the treatment of gastric affections and sluggish action of the bowels and in hepatic disorders, also in debilitated states generally. The water is tepid, and is thought to receive its highly sodic mineralization qualities from the deep subterranean source of the underlying saliferous "red beds." The water is highly charged with natural carbonic-acid gas. The contained iron is a natural bicarbonate, but on reaching the surface, under released pressure, the gas escapes and the iron is precipitated as an oxide in and about the springs.

## San Ysidro Springs.

(*Sandoral County.*)

*Postoffice,* San Ysidro. *Location,* a little to the north of central New Mexico; west of Santa Fe, the capital city, 47 miles; north of Albuquerque, 62 miles; west of Las Vegas, 90 miles. *Situation,* in the region known as the Jemez plateau, on a mesa, or tableland, 6600 feet above sea level. The springs, some 40 in number, arise on either side of the Rio Talado River, in its lower course. Those on the south side of the river are "bitter" magnesium waters and those on the north bank are soda springs. *Access,* via the Santa Fe Railway System to Rosario Station, thence by motor 30 miles to the springs. *Hotel,* accommodations primitive. The analysis below shows the mineralization of one of the soda springs. This analysis was made by Oscar

Lowe, and is considered one of the most important medicinal waters in the state of New Mexico. The water as it issues from the earth is highly charged with natural carbonic-acid gas.

SAN YSIDRO SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, Oscar Lowe). |
|---|---|
| Sodium chloride ($NaCl$) | 307.20 |
| Sodium sulphate ($Na_2SO_4$) | 163.90 |
| Potassium sulphate ($K_2SO_4$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1659.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 108.54 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.29 |
| Lithium bicarbonate ($Li[HCO_3]_3$) | trace |
| Silica ($SiO_2$) | trace |
| Total solids | 2240.13 |

Medicinal classification, alkaline b or (Ab). The analysis reveals this to be a moderately highly mineralized, magnesic bicarbonated, sodic, sulphated and muriated saline water, possessing diuretic and antacid properties, and should be a valuable water in stomach and bowel disorders, in jaundice and hepatic diseases and also in bladder and kidney affections.

The following springs were once used as resorts:

*Aztec Spring* (*Ojo Xiganti*), *P. O.*, Santa Fe County. This spring was once used as a resort. No definite information nor satisfactory analysis available.

*Caballo Springs*, *P. O.*, Fort McRae, Socorro County. This is a thermic water. No definite information nor satisfactory analysis available.

*Chico Hot Springs*, *P. O.*, Maxwell City, Colfax County. This was once a popular resort with good hotel accommodations and varied amusements. No definite information nor satisfactory analysis available.

*Faywood Hot Springs*, *P. P.*, Faywood, Grant County. Of late years these springs have become noted for their curative properties. No definite information nor satisfactory analysis available.

*Gallo Spring*, *P. O.*, Grant, Valencia County. No definite information nor satisfactory analysis available.

*Gila Hot Springs*, *P. O.*, Diamond Creek, Socorro County. No definite information nor satisfactory analysis available.

*Hudson Hot Springs*, *P. O.*, Hudson, Grant County. The location is 25 miles from Deming, at an elevation of 5000 feet above sea level. This was once a popular resort, but the hotel was destroyed by fire, and so far as we have been able to learn has not been rebuilt. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "unknown."

*Las Palomas Hot Spring*, *P. O.*, Engle, Sierra County. Location, on the Rio Grande River. Of late years this spring is said to have

merited some popularity as a resort. No definite information nor satisfactory analysis available.

*Patterson's Springs, P. O.*, Patterson, Socorro County. No definite information nor satisfactory analysis available.

*Selden Hot Springs, P. O.*, Las Cruces, Dona Ana County. This spring at one time had quite a reputation for the treatment of rheumatism, etc.

*Socorro Thermic Springs, P. O.*, Socorro, Socorro County. The flow of water is said to be 700,000 gallons in twenty-four hours from the whole group. The water is used for the domestic water supply of the town of Socorro. No definite information nor satisfactory analysis available.

*Warm Sulphur Springs, P. O.*, Rio Pajarito, Taos County. This spring was first analyzed in 1875. The native people ascribe many virtues to the sublime healing powers of the waters. The waters are said to be highly charged with carbonic acid and hydrogen sulphide. No definite information nor satisfactory analysis available.

## NEW YORK.

New York extends from 71°51′ to 79°47′25″ west longitude and from 40°29′40″ to 45°0′42″ north latitude, and comprises an area of 49,170 square miles, of which 6550 square miles are under water. The length of the state from north to south is 312 miles, and from east to west the breadth is 326 miles. The topographical features of the state is varied and complex. The great Appalachian belt first comes out upon the coast in this state. In the eastern part of the state the Catskill mountains cover over 500 square miles of territory and reach a height of 3800 feet. The Adirondack mountains, in the rugged region west of Lake Champlain, rise to various heights, some of the loftiest peaks reaching an elevation of 5337 feet above sea level. The state contains among its varied attractions more than 1000 lakes, many of them of rare beauty and attractiveness; some of the lakes are of considerable area, and nearly all are of the elongated type, originally formed by the damming of river valleys by glacial deposts. The largest lakes are Seneca and Cayuga, each nearly 40 miles long and from 2 to 3 miles wide. The pleasure resorts of the state along its lakes, waterways and at its mineral springs are among the most attractive and popular in the whole country. There is a great diversity of climate, subject to sharp and sudden changes, but on the whole healthful and delightful. The mean annual temperature, as observed at Albany, is 8° C. (47.95° F.); in the city of New York, 11° C. (51.83° F), though in the northwestern section of the state the temperature often falls to −32.9° or −34.4° C. (25° or 30° F. below zero).

New York has 200 spring localities, with a total of 343 individual springs, 173 of which have been analyzed, and 25 used as resorts. The mineral springs of the state are numerous, and many of them

widely celebrated. The U. S. Geological reports credit the state with a larger number of spring localities, with one exception, of any state in the Union. The great majority of the mineral waters are sulphuretted, with saline and chalybeate elements predominating, but it will be observed that all types of mineral waters are found within the state. At least one spring, Oak Orchard, is of special interest, containing free sulphuric acid. The Saratoga Springs are the most widely known of the American springs, and at the present time, the state of New York being the owner, large appropriations are being spent to make it the greatest spa in America. The following list has been secured from personal investigation, from correspondence and from the published literature on the subject, and is fairly representative of the springs in active use today.

### Avon Sulphur Springs.

(*Livingston County.*)

*Postoffice*, Avon. *Location*, in western New York; east of Syracuse, 85 miles; south of Rochester, 20 miles; north of Dansville, 30 miles. *Situation*, west of the celebrated Finger Lake section of the state, in the valley of the Genesee River, at an elevation of about 1800 feet above sea level, surrounded by a rolling hilly country. *Access*, via the Erie Railway System, thence a short distance by motor to the springs. *Hotel*, there are 3 hotels, providing modern accommodations. The surrounding country is delightfully interspersed with good macadam roads, charming lakes, beautiful streams and picturesque vistas, pleasing to the eye. There are 3 springs, the analyses of which show the mineralization:

AVON SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, J. Hadley.) Upper Spring. | (Analyst, J. R. Chilton.) Lower Spring. | (Analyst, H. M. Baker.) Congress Spring. |
|---|---|---|---|
| Sodium chloride (NaCl) | 314.64 | ... | 497.78 |
| Calcium chloride ($CaCl_2$) | ... | 143.81 | |
| Sodium iodide (NaI) | ... | trace | |
| Sodium sulphate ($Na_2SO_4$) | 273.60 | 234.78 | 359.44 |
| Magnesium sulphate ($MgSO_4$) | 171.00 | 848.33 | 326.09 |
| Calcium sulphate ($CaSO_4$) | 1436.40 | 982.22 | 472.13 |
| Sodium sulphide ($Na_2S$) | ... | ... | 948.24 |
| Calcium sulphide (CaS) | ... | ... | 754.06 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 221.61 | 812.49 | 256.24 |
| Silica ($SiO_2$) | trace | trace | trace |
| Total solids | 2417.25 | 3021.63 | 3413.98 |
| Gases: | | | |
| Hydrogen sulphide, cc. per liter | 41.4 | 34.5 | 95.3 |
| Carbon dioxide, cc. per liter | 19.0 | 13.5 | 76.4 |
| Oxygen, cc. per liter | ... | 1.4 | 3.6 |
| Nitrogen, cc. per liter | ... | 18.6 | 13.4 |

Upper Spring, medicinal classification, calcic sulphated or (CaS), sulphuretted. This is a moderately highly mineralized, calcic, sodic, magnesic sulphated, alkaline-saline water, sulphuretted, possessing diuretic and laxative properties.

Lower Spring, medicinal classification, weak alkaline b2, sulphated or (−Ab2, S), sulphuretted. This is a moderately highly mineralized, calcic, magnesic, sodic, sulphated alkaline-saline water, sulphuretted, azotized, possessing diuretic and purgative properties.

Congress Hall Spring, medicinal classification, weak sulphide 4, weak sulphated 3 or (−Sul.4, −S3), sulphuretted. This is a moderately highly mineralized, calcic, sodic, magnesic, sulphated muriated, alkaline-saline water, sulphuretted, carbon-dioxated, azotized. This water is also highly charged with the sulphate of sodium and calcium. This water possesses valuable laxative and purgative properties. These waters are useful in the treatment of disorders of the gastro-intestinal tract, sluggish hepatic function and stasis of the intestinal tract. The water exerts a marked diaphoretic action through increased activity of the functions of the integumentary system. The water exerts valuable antacid properties in distressed acidity of the stomach. The waters have been used both internally and externally (as baths) in the treatment of rheumatism.

## Baldwin Mineral Spring.

(*Cayuga County.*)

*Postoffice,* Cayuga. *Location,* in the midwestern portion of the state; southwest of Syracuse, 30 miles; west of Auburn, 10 miles. *Situation,* at the northern end of Cayuga Lake, in the midst of the beautiful Finger Lake section of the state. *Access,* Cayuga Station, on the New York Central Railway, thence 2 miles by motor to the springs. *Hotels,* no accommodations for guests. The springs on analysis reveals the following mineralization:

BALDWIN MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. F. Long). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.34 |
| Sodium chloride ($NaCl$) | 33.80 |
| Sodium sulphate ($Na_2SO_4$) | 39.70 |
| Magnesium sulphate ($MgSO_4$) | 524.70 |
| Calcium sulphate ($CaSO_4$) | 1680.40 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 284.90 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 2.50 |
| Ferric oxide ($Fe_2O_3$) | 1.10 |
| Aluminic oxide ($Al_2O_3$) | 1.40 |
| Silica ($SiO_2$) | 15.00 |
| Total solids | 2585.84 |

Medicinal classification, calcic sulphated or (CaS). This is a moderately highly mineralized, calcic, magnesic, sulphated, alkaline-saline water, possessing diuretic and laxative action. The owner submits authentic letters from reputable physicians, attesting the therapeutic action of this water in the treatment of rheumatic and arthritic affections and for the relief of gastric and genito-urinary disturbances. When this water is administered in large amounts a purgative action will be secured through stimulation of the musculature of the intestinal tract, by the action of the sulphate ions which liquefy the intestinal contents. The waters have been bottled and shipped for many years. The bottling plant is sanitary, and every care is taken to protect the waters from contamination. The waters will keep for years. They have an enviable reputation in western New York.

### Ballston Spa.

(*Saratoga County.*)

*Postoffice*, Ballston. *Location*, near the eastern boundary of the state; north of Albany, the capital city, 32 miles; south of Saratoga Springs, 6 miles; north of New York City, 180 miles. *Situation*, on the southern slope of the Adirondack Mountains, at the lower end of a beautiful valley extending from Ballston Spa to Quaker Ridge. *Access*, via main line of the Delaware & Hudson Railway; via the Schnectady Railway (trolley) and the Hudson Valley Railway (trolley), connecting Troy, Albany, Glens Falls and Saratoga, and runs within 100 feet of the Ballston Spa; the railway depots are within ½ mile of the springs. *Hotels*, there are several modern hotels in the village, offering accommodations for visitors and guests. The springs, 4 in number, possess potent therapeutic properties, and in the early days were a formidable rival of the present celebrated Saratoga Springs, only 6 miles away. We present the analysis of one of the springs, which shows the following mineralization:

BALLSTON SPA.

| Hypotheti calcombinations. | Parts per 1,000,000 (Analyst, State Dept. of Health). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 43.0 |
| Lithium chloride (LiCl) | 94.0 |
| Sodium chloride (NaCl) | 11,186.7 |
| Potassium chloride (KCl) | 602.5 |
| Potassium bromide (KBr) | 89.3 |
| Potassium iodide (KI) | 3.0 |
| Sodium sulphate ($Na_2SO_4$) | 4.4 |
| Sodium bicarbonate ($NaHCO_3$) | 1,571.9 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2,822.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 4,007.2 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 24.7 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 63.7 |
| Aluminum oxide ($Al_2O_3$) | 2.6 |
| Silica ($SiO_2$) | 27.6 |
| Total solids | 20,542.6 |
| Temperature, °C. | 10 |

Medicinal classification, strong alkaline b, strong saline (iodic) (+Ab, +Cl(I)). As will be seen from the analysis, this is a highly mineralized, sodic, potassic, muriated; sodic, magnesic bicarbonated, alkaline-saline water (bromic), possessing diuretic, tonic and alterative properties. This water has long been popular with the profession in a variety of ailments in which water of this type is indicated, especially in disorders of the stomach and intestines, bladder and kidney affections and in constipation. The waters are very similar to the celebrated Saratoga waters; indeed, some of the Ballston Springs are richer in the predominating chemical elements than the Saratoga waters.

## Breesport Mineral Springs.

(*Chemung County.*)

*Postoffice,* Breesport. *Location,* in the mid-section of the southern tier of counties of the state; west of Binghamton, 45 miles; south of Seneca Lake, 25 miles; north of Elmira, 10 miles. *Situation,* in a rolling mountain section of country, about 1200 feet above sea level, lying to the south of the beautiful Finger Lake section of the state. *Access,* via Lehigh Valley Railway, only about 500 feet from the springs. *Hotel,* no accommodations for guests. The waters are bottled and shipped extensively. The analysis below shows the mineralization:

BREESPORT MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Cornell Univ.). |
|---|---|
| Lithium chloride ($LiCl$) | trace |
| Sodium chloride ($NaCl$) | 992.93 |
| Sodium sulphate ($Na_2SO_4$) | 1.71 |
| Sodium nitrate ($NaNO_3$) | none |
| Sodium bicarbonate ($NaHCO_3$) | 433.62 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 56.17 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 91.54 |
| Potassium bicarbonate ($KHCO_3$) | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | trace |
| Manganous oxide ($Mn_2O_3$) | trace |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silica ($SiO_2$) | 0.88 |
| Total solids | 1576.85 |

Medicinal classification, weak alkaline a, weak saline 2 or (−Aa, −Cl 2). The analysis shows a moderately highly mineralized, sodic bicarbonated and muriated, alkaline-saline water, carbon-dioxated, possessing diuretic and antacid properties. The water also carries traces of the bicarbonates of iron and manganese, which impart to it tonic and alterative properties. It is a very pure palatable wholesome water, of therapeutic value in kidney and bladder disturbances. It ought to be of value in the treatment of digestive disorders due to an excess of acidity, such as pyrosis, water brash, etc.

## Chittenago Sulphur Springs.

(*Madison County.*)

*Postoffice*, Chittenago. *Location*, in central New York; east of Syracuse, 15 miles; west of Albany, the capital city, 115 miles; north of Binghamton, 68 miles. *Situation*, in the beautiful lake region, at an elevation of about 1800 feet above sea level. Through the valley, between the hills, flows the outlet of Cazenova Lake to Oneida Lake, a beautiful stream some 70 feet in width. *Access*, via the New York Central lines and the New York West Shore Railway. *Hotel*, the hotel is a commodious structure, with modern conveniences for accommodating 300 guests. The springs, 3 in number, have the following mineralization, as revealed by the analysis below:

CHITTENAGO SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. C. F. Chandler). White Sulphur Spring. | Lithium Sulphur Spring. | Magnesia Sulphur Spring. |
|---|---|---|---|
| Lithium chloride ($LiCl$) | trace | trace | trace |
| Potassium chloride ($KCl$) | 2.73 | 3.93 | 5.64 |
| Sodium chloride ($NaCl$) | 17.78 | 24.84 | 31.29 |
| Sodium sulphate ($Na_2SO_4$) | 3.59 | | |
| Magnesium sulphate ($MgSO_4$) | 33.34 | 126.78 | 217.51 |
| Calcium sulphate ($CaSO_4$) | 1392.28 | 1814.65 | 1968.03 |
| Strontium sulphate ($SrSO_4$) | trace | trace | trace |
| Sodium sulphide ($Na_2S$) | 2.05 | 6.66 | 12.82 |
| Calcium sulphide ($CaS$) | ... | 18.55 | 15.90 |
| Sodium hyposulphite ($NaHSO_2$) | ... | 4.44 | 0.34 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 376.54 | 409.88 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.26 | 3.76 | 576.02 |
| Aluminum oxide ($Al_2O_3$) | 1.36 | 3.76 | trace |
| Silica ($SiO_2$) | 4.78 | 8.89 | 9.91 |
| Total solids | 2235.71 | 2426.87 | 2837.66 |
| Gases: | | | |
| Carbon dioxide, free, cc. per liter | 70.6 | 57.4 | 67.2 |
| Hydrogen sulphide, cc. per liter | 3.2 | 9.5 | 19.4 |

White Sulphur Spring, medicinal classification, weak alkaline b, weak calcic sulphated 4 or (−Ab, −CaS4), sulphuretted. This is a moderately highly mineralized, calcic, sulphated and magnesic, bicarbonated alkaline-saline water, carbon-dioxated, sulphuretted, possessing diuretic and weak antacid properties.

Lithium Sulphur Spring, medicinal classification, weak alkaline b, calcic sulphated or (−Ab, CaS), sulphuretted. This is a moderately highly mineralized, calcic, magnesic, sulphated and magnesic, bicarbonated alkaline-saline water, weakly carbon-dioxated, sulphuretted, possessing diuretic, slight laxative, antacid, tonic and reconstructive properties.

Magnesia Sulphur Spring, medicinal classification, calcic sulphated,

weak ferruginous or (CaS, —Fe), sulphuretted. This is a moderately highly mineralized magnesic calcic, sulphated and ferruginous bicarbonated alkaline-saline water, weakly carbon-dioxated, sulphuretted.

The water from White Sulphur Spring contains traces of free sulphur, which imparts to the water its pearly-white hue. This water is recommended in the treatment of rheumatism, neuralgia, gout and various types of chronic skin diseases. The water from Lithia Spring is a perfectly clear water, pleasing to the taste and has the endorsement of the profession in the treatment of kidney and bladder affections. The water from Magnesia Spring is also transparent, but deposits a sediment, said to consist of magnesia, yellow sulphur and the chloride of potassium. The sediment, no doubt, contains the oxide of iron also, as the iron bicarbonate, on evaporation, loses the natural carbonic-acid gas, oxidizes and forms a yellowish sediment.

## Cherry Valley Springs.

(*Otsego County.*)

*Postoffice,* Cherry Valley. *Location,* in south of central New York; west of Albany, the capital city, 54 miles; east of Auburn, 95 miles. *Situation,* in the Mohawk Valley, on the western foothills of the Catskill Mountains, and east of Otsego Lake, at an elevation of about 1250 feet above sea level. Nearby is the Tekaharawa Falls, situated in a dark, wooded hemlock forest, a small stream abruptly pours over a perpendicular precipice, and dashes 152 feet to the bottom of the chasm below. From the south you approach the falls to the very border of the gulf, before you are aware, from any topographical feature of the surroundings that you are approaching a yawning abyss. *Access,* via the Susquehanna Division of the Delaware & Hudson Railway to Cherry Valley Station, thence by motor 2 miles to the springs. *Hotel,* no definite information available as to class of accommodation, but we learn that a hotel and bathing establishment are open to visitors. The springs, 2 in number, have the following mineralization, as revealed by analysis:

Bath House Spring, medicinal classification, weak alkaline b2, weak calcic sulphated 4 or (—Ab2, —CaS4). This analysis shows the spring to be a moderately highly mineralized, calcic, magnesic, sodic, sulphated and bicarbonated alkaline-saline water, sulphuretted, possessing diuretic, antacid and slight laxative properties.

North Bath House Spring, medicinal classification, weak alkaline b2, calcic, sulphated, very weak ferruginous or (—Ab2, CaS, ——Fe). This is a moderately highly mineralized, calcic sulphated and bicarbonated alkaline-saline (ferruginous) water, sulphuretted, possessing diuretic, weak antacid and weak tonic properties.

CHERRY VALLEY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, J. R. Chilton.) Bath-house Spring. | (Analyst, Dr. Perkins.) North Bath-house Spring. |
|---|---|---|
| Potassium chloride (KCl) | ... | 42.57 |
| Sodium chloride (NaCl) | 212.72 | |
| Magnesium chloride ($MgCl_2$) | 62.92 | 36.42 |
| Calcium chloride ($CaCl_2$) | 47.88 | |
| Sodium sulphate ($Na_2SO_4$) | 189.46 | |
| Magnesium sulphate ($MgSO_4$) | 319.97 | |
| Calcium sulphate ($CaSO_4$) | 986.32 | 2555.76 |
| Calcium sulphide (CaS) | 10.26 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 312.20 | 257.91 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 261.67 | 408.44 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 67.86 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.73 | 1.00 |
| Silica ($SiO_2$) | 4.78 | 62.24 |
| Total solids | 2410.91 | 3432.20 |

## Clifton Springs.

(*Ontario County.*)

*Postoffice*, Clifton Springs. *Location*, in midwestern New York; west of Syracuse, 60 miles; east of Buffalo, 100 miles; southeast of Rochester, 30 miles; northwest of Watkins Glen, 50 miles; northwest of Geneva, 12 miles; northeast of Canandaigua, the county seat, 12 miles. *Situation*, in the northern part of the Finger Lake region of the state, at about 620 feet above sea level. Just south of Clifton Springs begins the hilly section which gradually merges into the mountainous region of the state of Pennsylvania. The average summer temperature ranges from 24.4° to 30° C. (76° to 86° F.). *Access*, via Lehigh Valley main line between New York City, Philadelphia Buffalo, also via Auburn Branch of the New York Central Railway, making direct connections at Rochester with the main lines of the New York Central; New York, Lake Erie & Western; Buffalo, Rochester & Pittsburgh Railway; Delaware, Lackawanna & Western Railway; Pennsylvania at Canandaigua and Rochester. *Hotel*, the Clifton Springs Sanitarium and Clinic offers superior accommodations, with all modern conveniences. The bathing establishment is modern in construction and equipment which, with the treatment rooms, comprise an establishment unsurpassed for the scientific medical treatment of disease. The balneotherapeutic department comprises every known bath from the Nauheim to the simplest rub or pack. The physiotherapeutic department is complete and very efficient. The staff consists of 20 physicians, including 3 surgeons, specialists in their respective fields. The roentgen-ray laboratory is available for all examinations when desired. The pathological, bacteriological, biochemical and clinical laboratories are coördinated working units of the medical and surgical divisions of the sanitarium and clinic. On

arrival the patient is given a thorough examination, and after all laboratory reports are reviewed and a diagnosis made the patient is referred to the member of the staff who specializes on the particular condition the case presents and the treatment is directed through his advice and counsel. There are several springs in this area, but the following, as shown by the analysis, is the most important, due to its sulphur content:

CLIFTON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Richard S. Curtis). |
|---|---|
| Potassium chloride (KCl) | 60.0 |
| Sodium chloride (NaCl) | 26.0 |
| Sodium sulphate ($Na_2SO_4$) | 42.8 |
| Magnesium sulphate ($MgSO_4$) | 324.1 |
| Calcium sulphate ($CaSO_4$) | 1033.9 |
| Acid sodium phosphate ($NaH_2PO_4$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 465.9 |
| Ferric oxide and alumina ($Fe_2O_3Al_2O_3$) | 1.5 |
| Silica ($SiO_2$) | 7.6 |
| Total solids | 1961.8 |
| Gases: | |
| Hydrogen sulphide | 11 |
| Carbon dioxide | 70 |

Medicinal classification, weak alkaline b, weak calcic sulphated 3 or (−Ab, −CaS3) sulphuretted. This is a moderately highly mineralized, calcic and magnesic, sulphated, alkaline-saline water, sulphuretted and carbon-dioxated, possessing diuretic, antacid and slight tonic properties. This water is quite similar to that of the celebrated White Sulphur Springs in West Virginia. It has been found from long experience that this water is beneficial in disorders, due to abnormal conditions of the blood or to derangements of the stomach, liver, bowels and kidneys, skin and nervous system. Its use has given satisfactory results in the treatment of indigestion, due to hyperacidity and in chronic constipation, jaundice, etc.

## Colonial Springs.

### (*Suffolk County.*)

*Postoffice*, West Deer Park, via Babylon. *Location*, on Long Island; east of New York City, 34 miles. *Situation*, near the base of a bluff that rises about 100 feet above the great plain of Long Island. The spring bursts through a strata of clay in which are found large deposits of iron and other minerals. The elevation is about 200 feet above tide water, near the middle of Long Island, and is surrounded by prosperous truck farms and attractive homes. The whole section is intersected with splendid macadam highways. *Access*, via the Long Island Railway. *Hotel*, a resort hotel offers modern accommodations, but no recent definite information available. There are 2 springs.

COLONIAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Chandler & Pellew). Colonial Spring. | Mo-Mo-Ne Spring. |
|---|---|---|
| Potassium chloride (KCl) | 7.43 | 2.73 |
| Sodium chloride (NaCl) | 13.68 | 8.20 |
| Potassium sulphate ($K_2SO_4$) | 3.24 | 2.05 |
| Sodium bicarbonate ($NaHCO_3$) | ... | 1.66 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 4.70 | 3.60 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 9.97 | 2.48 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.34 | 0.34 |
| Silica ($SiO_2$) | 8.37 | 11.28 |
| Total solids | 47.73 | 32.34 |

Colonial Spring is a slightly mineralized, sodic, potassic, muriated, alkaline-saline water, possessing diuretic and slight antacid properties.

Mo-Mo-Ne Spring is a slightly mineralized, sodic, muriated, bicarbonated alkaline-saline water, possessing diuretic and slight antacid properties. These waters are pure, wholesome and agreeable, and have been found useful where a mild diuretic action is desired. It is said that these waters are endorsed by the local profession.

## Dietade Mineral Spring.

*(Clinton County.)*

*Postoffice*, Keeseville. *Location*, in the northeastern corner of the state; 90 miles south of Montreal, Can., and 150 miles north of Albany, the capital city. *Situation*, at the foothills of the Adirondacks, hemmed in by pine-forest-covered mountains, and near the great natural wonder of the east, the Au Sable Chasm, in the Adirondacks, where for countless ages the waters have chiseled a vast fissure more than 100 feet in depth through a solid mountain of stone. *Access*, Keeseville is situated on the main line of the Delaware & Hudson Railway. *Hotel*, good hotel accommodations and cottages for guests who desire quiet and seclusion. The Dietade Mineral Spring Water, as analyzed by Prof. Geo. A. Ferguson, shows the following mineralization:

DIETADE MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. A. Ferguson). |
|---|---|
| Potassium chloride (KCl) | 18.29 |
| Sodium chloride (NaCl) | 37.97 |
| Sodium sulphate ($NaSO_4$) | 50.47 |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium nitrite ($NaNO_2$) | 1.96 |
| Sodium bicarbonate ($NaHCO_3$) | 77.44 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 312.03 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 140.05 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 3.00 |
| Total solids | 641.21 |
| Gases: | |
| Hydrogen, sulphuretted | trace |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic, sodic, bicarbonated alkaline-saline water, and is highly recommended by local physicians for its efficient aperient and alterative action. It has proven useful in the treatment of digestive disturbances, general debility and, due to its iron content has valuable tonic properties.

Every seasonable kind of sport and recreation is available to guests according to taste, fishing, hunting, bathing, skating, snowshoeing, skiing and motoring, besides the golf course is one of the best in this section of the state. The view across Lake Champlain is gorgeous; at its widest part, sparkling under the summer's sun, with the Green Mountains for a background, presents a panoramic vista never to be forgotten.

## Deep Rock Spring.

*(Oswego County.)*

*Postoffice*, Oswego. *Location*, on the northern border of the state, fronting on Lake Ontario; north of Syracuse, 40 miles. *Situation*, on the border of and overlooking Lake Ontario, amid the most charming surroundings, near where the Oswego River enters the lake. *Access*, via the Delaware, Lackawanna & Western Railway and the New York, Ontario & Western Railway. *Hotel*, no preparation to entertain guests, but there are good hotels in the city of Oswego. The Deep Rock Spring has been known to the public since 1870, when it was opened, and the water extensively advertised; since that time the water has had an extensive sale, competing fairly with the most popular table waters on the market. The following analysis shows the mineralization:

DEEP ROCK SPRING.

| Hypothetical combinations. | Parts per 1000,000, (Analyst, A. Richter, Ph.D.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.2520 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 6.9000 |
| Sodium chloride (NaCl) | 1948.0000 |
| Sodium sulphate ($Na_2SO_4$) | 57.4000 |
| Calcium phosphate ($Ca_3PO_4$) | trace |
| Sodium nitrate ($NaNO_3$) | 12.1300 |
| Sodium nitrite ($NaNO_2$) | 0.0048 |
| Sodium bicarbonate ($NaHCO_3$) | 216.9000 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 21.0000 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 53.1000 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.4000 |
| Silica ($SiO_2$) | 10.6000 |
| Total solids | 2326.6868 |
| Temperature, °C. | 13.3 |

Gases:

| | |
|---|---|
| Carbon dioxide, free, at 0° C., 760 mm. paressure, cc. per liter | 3.1 |
| Carbon dioxide from evaporation to dryness, cc. per liter | 39.4 |

Medicinal classification, saline or (Cl). The analysis shows this to be a moderately highly mineralized, sodic, muriated, saline water, slightly carbon-dioxated, possessing diuretic, antacid and aperient properties. This water contains, perhaps, a larger percentage of potassium chloride of any known spring which imparts to it important therapeutic properties. This water acts by stimulating the circulation, increasing the secretion of mucous and thereby aiding bowel action. Practically the entire output from the springs is bottled and shipped. Every precaution is exercised to insure sanitary cleanliness in the production of the water.

## Geneva Mineral Spring.

(*Ontario County.*)

*Postoffice*, Geneva. *Location*, in western New York; west of Syracuse, 50 miles; southeast of Rochester, 45 miles; north of Elmira, 55 miles; north of the celebrated Glen Springs at Watkins Glen, 45 miles; east of Buffalo, 100 miles. *Situation*, on the lower end of Seneca Lake, in the heart of the Finger Lake region, at an elevation of about 1800 feet above sea level. *Access*, via Geneva Station, on the Auburn Division of the New York Central Railway; splendid train service east and west. *Hotels*, there are good hotel accommodations in the city. The well-known Geneva Lithia Water is obtained from a well 930 feet in depth, piercing a stratum of impervious rock defined by a layer of medieval sandstone 60 feet in thickness and by a deep substratum of hard slate. The water is forced upward by hydrostatic pressure, 120 pounds to 1 square inch, and if not impeded at the surface it would form a geyser-like fountain, sending a stream 80 feet into the air. The following analysis shows the mineralization:

GENEVA MINERAL SPRING.

| Hypothetical combinations. | Part per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.048 |
| Lithium chloride (LiCl) | 0.600 |
| Potassium chloride (KCl) | 7.600 |
| Sodium chloride (NaCl) | 330.400 |
| Potassium iodide (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 2.800 |
| Magnesium sulphate ($MgSO_4$) | 575.300 |
| Calcium sulphate ($CaSO_4$) | 1500.200 |
| Sodium metaborate ($NaBO_2$) | trace |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium nitrate ($NaNO_3$) | 0.600 |
| Sodium nitrite ($NaNO_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 325.700 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.000 |
| Silica ($SiO_2$) | 14.200 |
| Total solids | 2758.448 |

Medicinal classification, calcic sulphated or (CaS). The analysis shows this to be a moderately highly mineralized, calcic, sulphated saline water, possessing antacid, diuretic, antilithic, alterative and restorative properties. There are not sufficient sulphate radicles of magnesium and sodium to give it laxative action; the lithia and calcium sulphate exert diuretic and antilithic action, while there is enough iron to exert slight tonic action when taken continuously. The water has been highly endorsed by prominent physicians of the great eastern cities. It is bottled and shipped throughout the entire country. The bottling plant is modern in construction and equipment, meticulous care being supervised in the sanitary handling of the water. This water is quite similar to the spring now famous at Rippoldsau, in the Duchy of Baden, but the Geneva water contains more iron and free phosphoric acid. This water is extensively prescribed in anemia, chlorosis and general debility, and in the uric-acid diathesis. The administration of this water has given good results in the treatment of gout, rheumatism, renal and vesical calculi.

## Great Bear Springs.

(*Oswego County.*)

*Postoffice*, Fulton. *Location*, in western New York; south of Oswego, 15 miles; north of Syracuse, 25 miles. *Situation*, on the Oswego River, about midway between Oneida Lake and Lake Ontario, at an elevation of about 1250 feet above sea level. *Access*, via the New York Central lines. *Hotel*, no definite information as to class of accommodations, but good hotel at Fulton. These springs have been known and used since the coming of the white man and, according to legend, the aborigines knew of and appreciated the healing virtues of this water. The analysis below reveals the mineralization:

GREAT BEAR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.03 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 3.20 |
| Sodium chloride (NaCl) | 17.50 |
| Magnesium chloride ($MgCl_2$) | 11.00 |
| Sodium nitrate ($NaNO_3$) | 12.15 |
| Sodium nitrite ($NaNO_2$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 27.70 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 125.10 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.00 |
| Silica ($SiO_2$) | 9.70 |
| Total solids | 219.98 |
| Gases: | |
| Carbon dioxide, free, cc. per liter | 2.4 |
| Carbon dioxide set free on evaporation, cc. per liter | 21.7 |

The analysis shows this to be a lightly mineralized, calcic, bicarbonated alkaline water, (nitrated), possessing diuretic and antacid properties. The predominating chemical constituents are in the form of the bicarbonates, reaching 68 per cent of the total solids.

### Great White Sulphur Springs.

(*Otsego County.*)

*Postoffice*, Richfield Springs. *Location*, amid the rolling hills of Otsego County, just south of the Mohawk Valley, in the heart of the Great Empire state. *Situation*, only a short distance from the beautiful Canadaigua Lake, in a picturesque setting ,1750 feet above sea level, overlooking the hills of Otsego and Herkimer Counties, presenting vistas of incomparable scenic distinction on which to feast the eye. *Access*, via through trains on the New York Central & Hudson River Railroad and via the Delaware, Lackawanna & Western Railroad without change, and also via motor over splendid macadam road every mile of which presents a changing scenic panorama of great natural beauty. *Hotel*, there are 3 hotels, all under the same management, offering modern entertainment. The place has been conducted as a resort from June to October since 1820, more than one hundred years. The bathing establishment, a splendid brick structure, is equipped with modern appliances for the administration of the latest methods of hydrotherapeutic practice. There are 4 springs on the property, some of them widely known. The following analysis Great White Sulphur Spring shows the following mineralization, as determined by the Water Laboratory of the United States Department of Agriculture, Bureau of Chemistry:

GREAT WHITE SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Dept. Agr. Geol. Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 1.19 |
| Lithium chloride (LiCl) | 0.30 |
| Potassium chloride (KCl) | 5.91 |
| Sodium hydrosulphide (NaHS) | 35.95 |
| Sodium chloride (NaCl) | 1.42 |
| Magnesium sulphate ($MgSO_4$) | 531.17 |
| Magnesium chloride ($MgCl_2$) | 0.39 |
| Calcium sulphate ($CaSO_4$) | 1672.62 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 340.60 |
| Ferric oxide ($Fe_2O_3$) | 0.80 |
| Silica ($SiO_2$) | 18.80 |
| Total solids | 2609.15 |
| Dissolved gases, cc. per 1000 gm. at 0° C. and 700 mm. pressure: | |
| Carbon dioxide (free) | 28.20 |
| Hydrogen sulphide | 14.40 |
| Total gases | 42.60 |

Medicinal classification, calcic sulphated or (CaS), sulphuretted. This spring, as well as the other 3 has a flow of 5000 gallons each per

day. It is a moderately highly mineralized, calcic, magnesic, sodic, sulphated alkaline-saline water, sulphuretted. The high content of sulphuretted hydrogen makes this a very valuable sulphur water, an excellent therapeutic agent in the treatment of such constitutional diseases as gout, rheumatism and arthritis. Its alterative action is of marked value in the treatment of functional diseases of the liver, kidneys and digestive system. Besides the internal administration of this water as above, it is highly efficacious in the form of baths, as administered for the relief of eczema, psoriasis, acne and other skin affections. There is ample provision made for the entertainment and amusement of guests: balls, Germans, hops, with an excellent orchestra; out-of-door amusements, tennis, golf, motoring; indoor sports, billiards, pool and bowling; all serve to beguile the fleeting hours. The waters are also bottled and sold commercially. A resident physician is constantly on hand, to counsel with patients; long-distance telephone and telegraph facilities are in the hotel.

### Lebanon Warm Springs.

*(Columbia County.)*

*Postoffice*, Lebanon Springs. *Location*, in eastern New York, only a few miles from the Massachusetts boundary line; southwest of Albany, the capital city, 27 miles; west of Pittsfield, Mass., 10 miles. *Situation*, in the beautiful Lebanon Valley, nestling among the foothills on the western slope of the Berkshire Mountains, at an elevation of about 1200 feet above sea level. The spring gushes from a hillside in the immediate vicinity of the century-old Columbia Hall. *Access*, via the Rutland Railway, thence only $\frac{1}{4}$ mile to the springs. *Hotel*, the hotel has been newly remodeled and renovated, and now offers modern conveniences and accommodations throughout the year. The bathing department has been renovated and is now fitted out with modern equipment for various baths, showers, packs and plunges. The following analysis shows the mineralization.

LEBANON WARM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, H. Dussance). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 16.43 |
| Potassium sulphate ($K_2SO_4$) | 17.28 |
| Magnesium sulphate ($MgSO_4$) | 18.14 |
| Sodium bicarbonate ($NaHCO_3$) | 66.91 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 108.74 |
| Sodium sulphide ($Na_2S$) | 0.34 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 23.78 |
| Silica ($SiO_2$) | 55.61 |
| Organic matter | 85.55 |
| Total solids | 292.78 |
| Temperature, °C. | 24.4 |
| Gases: | |
| Oxygen, cc. per liter | 6.9 |
| Nitrogen, cc. per liter | 12.1 |
| Flow in gallons per day | 720,000 |

The analysis shows a moderately mineralized, thermic, calcic, sodic, bicarbonated alkaline water, oxygenated and azotized. This resort has been well known since pre-Revolutionary times. The waters are principally used for bathing.

## Massena Springs.

(*St. Lawrence County.*)

*Postoffice*, Massena Springs. *Location*, in northern New York; south of Cornwall, Canada, 15 miles. *Situation*, on Raquette River, which empties into the St. Lawrence, at an elevation of about 250 feet above sea level. *Access*, via the Rochester Division of the Rome, Watertown & Ogdensburg Railway, or via the Massena Springs branch of the Grand Trunk Railway to Massena Springs station. *Hotel*, this is one of the old-time resorts of the state. The hotel accommodations in the long ago were good. No recent information available as to class of accommodations. This resort was formerly known as the St. Regis Springs. There are 2 springs, the analyses of which are given below:

MASSENA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. W. J. Craw). St. Regis Spring. | Sulphur Spring. |
|---|---|---|
| Potassium chloride (KCl) | 8.72 | |
| Sodium chloride (NaCl) | 1313.10 | |
| Magnesium chloride ($MgCl_2$) | 511.80 | |
| Calcium chloride ($CaCl_2$) | ... | 181.94 |
| Magnesium bromide ($MgBr_2$) | 11.45 | |
| Sodium sulphate ($Na_2SO_4$) | 8.55 | |
| Magnesium sulphate ($MgSO_4$) | ... | 186.04 |
| Calcium sulphate ($CaSO_4$) | 1026.51 | 1169.64 |
| Sodium phosphate ($Na_2HPO_4$) | 22.57 | |
| Sodium hyposulphite ($Na_2S_2O_3$) | 71.99 | |
| Sodium sulphite ($Na_2SO_3$) | 23.94 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 82.93 | 409.98 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 8.37 | |
| Sodium silicate ($Na_2SiO_3$) | 191.17 | |
| Total solids | 3281.10 | 1947.60 |
| Gases: | | |
| Hydrogen sulphide, cc. per liter | 18.2 | 2.4 |

St. Regis Spring, medicinal classification, saline, weak calcic sulphated 3 or (−CaS3), sulphuretted. This spring shows a highly mineralized, sodic, muriated and calcic, sulphated, saline (bromic) water, sulphuretted, possessing diuretic, aperient, tonic and alterative properties. It is said to have been found useful in chronic skin diseases and in renal and vesical disorders. St. Regis Spring water resembles that of Eilsen, in the principality of Schumburg Lippe, but is much richer in sodium chloride than the latter.

Sulphur Spring, medicinal classification, weak alkaline b, weak calcic sulphated 3 or (−Ab, −CaS3), sulphuretted. This is a moderately mineralized, calcic muriated, sulphated bicarbonated alkaline-saline water, sulphuretted, possessing diuretic and slight laxative properties, and is said to be useful in the treatment of stomach and bowel disorders and in rheumatism.

### Oak Orchard Springs.

*(Genesee County.)*

*Postoffice*, Medina. *Location*, in western New York; west of Rochester, 40 miles; east of Niagara Falls, 35 miles; west of Syracuse, 120 miles. *Situation*, in a rolling region, between the Erie Canal on the north and Tonawanda Creek on the south, at an elevation of about 1000 feet above sea level. *Access*, via the New York Central Railway System to Medina, thence by motor south 6 miles to the springs, or by the New York Central System to Batavia, thence by motor 12 miles north to the springs. *Hotel*, none. This is not a resort, but the waters are bottled, sold and shipped. The analysis below shows the mineralization of these springs, which are remarkable for the notable quantities of free sulphuric acid they contain; more, indeed, with one or two exceptions, than any other waters known. Few springs contain free sulphuric acid, and none of this variety are known except in North America: The Tuscarora Sour Spring in Canada, the Matchless Mineral Wells in Alabama, the Sour Wells in Texas, the Bedford Iron and Alum Springs and Rock Bridge Alum Springs, Wallawhatoola Spring in Virginia and geysers in California. The analysis shows the mineralization:

OAK ORCHARD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, Norton.) Spring No. 1. | (Analyst, E. Emmons.) Spring No. 2. | (Analyst, Prof. Porter.) Oak Orchard Spring. |
|---|---|---|---|
| Sodium chloride (NaCl) | 52.72 | ... | 24.45 |
| Potassium sulphate ($K_2SO_4$) | 94.94 | ... | 42.40 |
| Sodium sulphate ($Na_2SO_4$) | 108.41 | ... | 54.03 |
| Magnesium sulphate ($MgSO_4$) | 608.76 | 81.15 | 145.17 |
| Calcium sulphate ($CaSO_4$) | 1580.61 | 212.21 | 234.61 |
| Aluminum sulphate ($Al_2SO_4$) | 370.89 | ... | 109.61 |
| Ferrous sulphate ($FeSO_4$) | 489.40 | 670.83 | 550.96 |
| Sulphuric acid, free ($H_2SO_4$) | 2303.88 | 2206.92 | 2277.60 |
| Silica ($SiO_2$) | 78.48 | 31.46 | 56.74 |
| Total solids | 4685.09 | 3002.57 | 3497.67 |

Spring No. 1, medicinal classification, acid sulphuric 2, calcic sulphated, weak aluminic ferruginous 2 or (AcS2, CaS, −Al Fe2). This is a moderately highly mineralized, calcic, magnesic, ferric, aluminic, sulphated acid water.

Spring No. 2, medicinal classification, acid sulphuric 2, weak ferruginous 2 or (AcS, —Fe2). This is a moderately highly mineralized, ferric, calcic, sulphated, acid water.

Spring No. 3, medicinal classification, acid sulphuric 2, weak calcic sulphated, weak aluminic ferruginous or (AcS, —CaS, —Al Fe2). This is a moderately highly mineralized, ferric, calcic, magnesic, alumnic, ferruginous sulphated acid water.

These waters possess diuretic, laxative, astringent and tonic properties. The water requires dilution before using. The waters are said to be of benefit in the treatment of chronic ulcers, diseases of the skin and in all atonic conditions of the mucous membranes and in depraved and impoverished conditions of the body from specific disease.

## Saratoga Springs.

(*Saratoga County.*)

*Postoffice*, Saratoga Springs. *Location*, in Saratoga County, at the foothills of the Adirondack Mountains; north of Albany, the capital city, 38 miles. *Situation*, on the high, dry Saratoga Plateau, with an elevation of 300 feet above sea level, and near the eastern boundary of the state; about the center of the valley, extending from Ballston Spa to Quaker Ridge. *Access*, via Saratoga Depot, on the main line of the Delaware, Lackawanna & Western Railroad, within four hours' ride from New York City. *Hotels*, there are a number in the town of Saratoga, furnishing ample and excellent accommodations for visitors; besides there are numerous smaller hotels and excellent boarding houses to fit the social aspirations and the exchequer of all classes. The Saratoga Springs property was purchased a few years ago by the state of New York, and is now a state reservation, administered by a commission, appointed by the State Legislature. The reservation comprises an area of 450 acres, and there are 122 springs and 1 geyser upon the property; there is found every natural mineral water and carbonated water peculiar to the Saratoga region. The geological strata underlying the Saratoga Plateau from above downward are: (*a*) Hudson River and Utica slate and shales; (*b*) Trenton limestone; (*c*) calciferous sand rock; (*d*) Potsdam sandstone; (*e*) Laurentian rocks of unknown thickness. Laurentian rocks are composed of highly crystaline gneiss, granite and syenite, and are almost impervious to water, while the Potsdam sandstone and calciferous sand rock immediately overlying permit it to pass freely. Many centuries past volcanic eruptions brought about an unusual disarrangement of the strata just described, leaving permanent faults or fissures within; the rainfall in the adjoining territory north of the fissures, except that which passes off as surface water, percolates through the different strata until it strikes the Laurentian rocks, thence it circulates within the bowels of the earth until it reaches a fissure where it accumulates.

From the faults or fissures in the Laurentian rocks, which are of an unknown thickness, carbonic acid doubtless arises and thus, in addition to the mineral constituents, the waters become highly charged with carbonic-acid gas. The continual accumulation of water and the pressure of the gas, together force the water to the earth's surface as springs, and in one instance into a geyser; the latter is produced by the hydrostatic pressure, deep down in the interior of the earth, with such force that it rises in a straight stream, spouting 20 feet into the air. It is known that volcanoes frequently emit quantities of carbon-dioxide gas, and this fact, with the known strata underlying Saratoga Plateau, may account for the unusual carbonation of the Saratoga waters.

The geological examination of the strata underlying the Saratoga Plateau spring region reveals a long geological fault; on the main line of this fault, or its lateral branches, are found all of the known springs in the Saratoga area. Excavations which have been made from time to time reveal solution channels in the rock, and the behavior of springs indicates that the entire underground region is a great network of such channels. The predominating ingredients of the Saratoga waters, as revealed by analyses (made by reservation chemists) are sodium chloride, the alkaline carbonates and carbonic-acid gas, and all of them contain one or more of the calcium salts.

SARATOGA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, chemist, Saratoga Con. Com.). | | | | |
|---|---|---|---|---|---|
| | Lincoln Spring. | Hathorn Spring No. 1. | Hathorn Spring No. 2. | Hathorn Spring No. 3. | Cosea Spring. |
| Ammonium chloride ($NH_4Cl$) | 11.93 | 23.74 | 42.82 | 48.70 | 35.83 |
| Lithium chloride (LiCl) | 27.62 | 27.55 | 42.52 | 70.82 | 39.64 |
| Potassium chloride (KCl) | 463.52 | 503.50 | 920.57 | 756.30 | 609.18 |
| Sodium chloride (NaCl) | 3136.35 | 3662.99 | 10,645.75 | 9,124.69 | 5,043.53 |
| Potassium bromide (KBr) | 19.50 | 22.00 | 60.00 | 51.66 | 29.67 |
| Potassium iodide (KI) | 1.00 | 1.50 | 3.50 | 2.10 | 1.36 |
| Sodium sulphate ($Na_2SO_4$) | trace | 6.54 | 6.70 | 10.04 | 8.37 |
| Sodium metaborate ($NaBO_2$) | trace | trace | trace | trace | trace |
| Sodium nitrate ($NaNO_3$) | trace | trace | trace | trace | trace |
| Sodium nitrite ($NaNO_2$) | trace | 0.12 | trace | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | 1368.99 | 400.05 | 344.51 | 526.32 | 830.34 |
| Barium bicarbonate ($Br[HCO_3]_2$) | 7.12 | 10.45 | 41.11 | 34.70 | 13.56 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace | trace | 4.07 | 1.14 | 2.74 |
| Magnesium bicarb. ($Mg[HCO_3]_2$) | 1301.02 | 1335.59 | 2,868.07 | 2,426.67 | 1,501.22 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1887.10 | 2288.92 | 3,953.17 | 3,504.67 | 2,786.01 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 39.81 | 27.26 | 21.59 | 18.34 | 25.48 |
| Alumina ($Al_2O_3$) | 15.12 | 1.77 | 6.31 | 21.77 | 1.18 |
| Silica ($SiO_2$) | 44.10 | 12.75 | 9.60 | 10.50 | 8.50 |
| Total solids | 8323.18 | 8414.73 | 18,972.29 | 16,608.42 | 10,956.62 |
| Temperature, °C. | 8 | | | | |

SARATOGA SPRINGS.—*Continued.*

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, chemist, Saratoga Con. Com.). | | | | |
|---|---|---|---|---|---|
| | Columbian Spring. | Polaris Spring. | Patterson. Spring. | Peerless Spring. | Karista Spring. |
| Ammonium chloride ($NH_4Cl$) | 5.15 | 6.18 | 18.38 | 17.57 | 62.38 |
| Lithiun chloride (LiCl) | 3.70 | 2.15 | 9.56 | 20.05 | 54.16 |
| Potassium chloride (KCl) | 82.93 | 154.02 | 327.97 | 315.69 | 845.71 |
| Sodium chloride (NaCl) | 295.59 | 1135.01 | 1567.60 | 2363.80 | 7,786.83 |
| Potassium bromide (KBr) | 12.00 | trace | 7.50 | 8.00 | 50.00 |
| Potassium iodide (KI) | 0.10 | trace | 0.25 | 0.40 | 1.00 |
| Sodium sulphate ($NaSO_4$) | 59.34 | trace | 83.37 | trace | 135.09 |
| Sodium metaborate ($NaBO_2$) | trace | trace | trace | trace | trace |
| Sodium nitrate ($NaNO_3$) | 2.43 | trace | trace | trace | trace |
| Sodium nitrite ($NaNO_2$) | trace | trace | trace | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | 358.76 | 741.14 | 691.14 | 722.38 | 2,801.38 |
| Barium bicarbonate ($Br[HCO_3]_2$) | 2.00 | 9.06 | trace | 15.11 | 16.00 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 0.23 | trace | trace | trace | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 446.29 | 461.93 | 736.13 | 922.50 | 2,371.46 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 878.58 | 1407.31 | 1531.64 | 2110.28 | 3,462.09 |
| Ferrous carbonate ($Fe[HCO_3]_2$) | 29.24 | 10.51 | 25.06 | 16.95 | 22.87 |
| Mangano-manganic oxide ($Mn_3O_4$) | none | none | none | none | none |
| Alumina ($Al_2O_3$) | 3.14 | 1.53 | 18.75 | 7.90 | 45.73 |
| Silica ($SiO_2$) | 47.80 | 10.80 | 26.60 | 19.20 | 28.20 |
| Total solids | 2227.28 | 3939.64 | 5043.95 | 6539.83 | 17,683.89 |

SARATOGA SPRINGS.—*Continued.*

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, chemist, Saratoga Con. Com,). | | | | |
|---|---|---|---|---|---|
| | High Rock Spring | Congress Spring No. 1. | Cong ress Spring No. 2. | Geyser Spring. | Emperor Spring. |
| Ammonium chloride ($NH_4Cl$) | 5.73 | 6.89 | 22.74 | 22.95 | 11.77 |
| Lithium chloride (LiCl) | 31.48 | 30.71 | 32.71 | 14.20 | 24.94 |
| Potassium chloride (KCl) | 73.42 | 191.13 | 363.17 | 222.13 | 198.70 |
| Sodium chloride (NaCl) | 325.63 | 2046.44 | 6,298.49 | 2172.97 | 2429.03 |
| Potassium iodide (KI) | 2.10 | 0.50 | 2.00 | 1.25 | 0.50 |
| Potassium bromide (KBr) | 8.30 | 7.50 | 34.90 | 15.00 | 17.00 |
| Sodium sulphate ($NaSO_4$) | 45.03 | 22.52 | 0.97 | 12.13 | 4.88 |
| Sodium metaborate ($NaBO_2$) | trace | trace | trace | trace | trace |
| Sodium nitrate ($NaNO_3$) | 3.21 | trace | trace | trace | 0.12 |
| Sodium nitrite ($NaNO_2$) | trace | trace | trace | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | 899.13 | 245.87 | 208.67 | 1607.15 | 169.83 |
| Barium bicarbonate ($BrHCO_2$) | 1.24 | 10.89 | 3.28 | 8.89 | 2.44 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | none | trace | trace | 2.06 | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 438.40 | 1207.69 | 1,327.04 | 785.83 | 884.58 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1226.83 | 1832.19 | 3,190.00 | 1849.54 | 2069.59 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 55.05 | 46.15 | 16.38 | 26.34 | 13.61 |
| Alumina ($Al_2O_3$) | 3.60 | 8.38 | 7.64 | 1.17 | 10.79 |
| Silica ($SiO_2$) | 25.30 | 28.30 | 7.58 | 16.30 | 13.95 |
| Total solids | 3134.25 | 5684.36 | 11,523.32 | 6757.91 | 5851.73 |
| Temperature °C | ... | ... | ... | ... | 10 |

Lincoln Spring, medicinal classification, alkaline ab2.5, saline 2 (iodic) or (Aab 2.5, Cl 2(I)). This is a highly mineralized, sodic potassic muriated, sodic magnesic bicarbonated, alkaline-saline (iodic, bromic) water, carbon-dioxated.

Hathorn Spring, No. 1, medicinal classification, alkaline b2, saline 2 (iodic) or (Ab2, Cl 2(I)). This is a highly mineralized, sodic potassic muriated, sodic, magnesic bicarbonated alkaline-saline (bromic, iodic) water, carbon-dioxated.

Hathorn Spring, No. 2, medicinal classification, alkaline b4, strong saline (iodic) or (Ab4, +Cl(I)). This is highly mineralized, sodic potassic muriated, sodic, magnesic bicarbonated alkaline-saline (bromic, iodic) water, carbon-dioxated.

Hathorn Spring, No. 3, medicinal classification, alkaline b3, strong saline (iodic) or (Ab3, +Cl(I)). This is a highly mineralized, sodic potassic muriated, sodic, magnesic bicarbonated alkaline-saline (bromic, iodic) water, carbon-dioxated.

Cosea Spring, medicinal classification, alkaline b2.5, saline 2.5 (iodic) or (Ab 2.5, Cl 2.5(I)). This is a highly mineralized, sodic potassic muriated, sodic magnesic bicarbonated alkaline-saline (bromic, iodic) water, carbon-dioxated.

Columbian Spring, medicinal classification, weak alkaline b4, weak saline or (−Ab4, −Cl). This is a moderately highly mineralized, potassic, sodic muriated, sodic, magnesic, bicarbonated alkaline-saline (iodic, bromic) water, carbon-dioxated.

Polaris Spring, medicinal classification, alkaline ab1.4, weak saline 3 or (Aab1.4, −Cl 3). This is a moderately highly mineralized, sodic potassic muriated, sodic, calcic, bicarbonated, alkaline-saline water, carbon-dioxated.

Patterson Spring, medicinal classification, alkaline b1.5, saline or (Ab1 .5, Cl). This is a moderately highly mineralized, sodic potassic muriated, sodic, calcic bicarbonated, alkaline-saline water, carbon-dioxated.

Peerless Spring, medicinal classification, alkaline b2, saline 1.4 or (Ab2, Cl 1.4). This is a moderately highly mineralized, sodic potassic muriated, sodic, calcic bicarbonated, alkaline-saline water, carbon-dioxated.

Karista Spring, medicinal classification, strong alkaline ab, saline 4 (iodic) or (+Aab, Cl 4). This is a highly mineralized, sodic potassic muriated, sodic, magnesic bicarbonated alkaline-saline (bromic, iodic) water, carbon-dioxated.

High Rock Spring, medicinal classification, alkaline ab, weak saline (iodic) or (Aab, −Cl(I)). This is a moderately highly mineralized, sodic potassic muriated, sodic, calcic bicarbonated alkaline-saline (iodic, bromic) water, carbon-dioxated.

Congress Spring, No. 1, medicinal classification, alkaline b1.5, weak saline or (Ab1.5, −Cl). This is a moderately highly mineralized, sodic potassic muriated, magnesic, calcic, bicarbonated, alkaline-saline (bromic) water, carbon-dioxated.

Congress Spring No. 2, medicinal classification, alkaline b2, saline 3 (iodic) or (Aab2, Cl 3(I)). This is a highly mineralized, sodic potassic muriated, sodic, calcic bicarbonated alkaline-saline (iodic, bromic) water, carbon-dioxated.

Geyser Spring, medicinal classification, alkaline ab2, saline (iodic) or (Aab2, Cl(I)). This is a moderately highly mineralized, sodic potassic muriated, sodic, calcic, bicarbonated alkaline-saline (bromic) water, carbon-dioxated.

Emperor Spring, medicinal classification, alkaline b1.5, saline or (Ab1.5, Cl). This is a moderately highly mineralized, sodic potassic muriated, calcic bicarbonated, alkaline-saline (bromic) water, carbon-dioxated.

It will be observed from a careful study of the analyses given herewith, of the most important of the Saratoga waters, that they will rank among the most important of their class to be found at any spa in the world; owing to their powerful potency, they should always, either at the springs or in the home, be administered only upon the advice of a competent physician. These waters are indicated in a wide range of diseases—the various forms of acidosis, functional diseases of the stomach, gastric and intestinal indigestion, constipation and catarrh of the gastro-intestinal tract, and the various afflictions associated with these conditions. The prescribing physician should always have a thorough knowledge of the pathology of the ailment before directing his patient to drink these waters. The state operates three magnificent bathing establishments; these are fitted up with the most improved appliances and appurtenances for the scientific administration of all types of hydrotherapeutic treatment, particularly cardiovascular disorders. Both mineralized and carbonated waters are pumped direct from the spring into the bath-house without decrease of the natural hydrostatic pressure. The waters, therefore, enter the tub in exactly the same condition as it issues from great depths below the earth's surface.

Saratoga Springs offer many attractions besides the wonderful waters and magnificent bathing establishments. The grounds of the reservation are beautifully and picturesquely adorned with ancient trees, beneath which are growing luxuriously beautiful flowers and perennial shrubbery. The climate is dry, bracing and invigorating, and close by is the beautiful Saratoga Lake, 9 miles long and from 4 to 5 miles wide, a placid sheet of water, nestling among the surrounding hills of great scenic beauty and attractiveness. A short distance away are some majestic peaks, among which may be mentioned Prospect Hill and Chapman Hill, both of an average elevation of some 2000 feet; 15 miles distant stands Bemi's Heights, where General Burgoyne surrendered to General Gates; all of these points are of easy access by motor, over the best of macadam roads passing through sylvian scenes of great beauty and attractiveness. (See also Chapter XV.)

## Sharon Springs.

*(Schoharie County.)*

*Postoffice*, Sharon Springs. *Location*, in the north central section of the state. *Situation*, in a most picturesque region, 1100 feet above sea level, rising out of the Mohawk Valley and lying between the Adirondack and Catskill Mountains. *Access*, via the Delaware & Hudson Railroad, direct to the springs; also via New York Central to Palatine Bridge, thence by motor 9 miles to the springs. This resort can be reached by motoring over the Mohawk, Onondaga and Iroquois Trails. *Hotel*, there is a hotel and cottages, with all modern conveniences furnishing accommodations for 500 guests. Connected with the hotel and cottages is the White Sulphur bathing establishment, equipped with all modern improvements for administering all kinds of baths. There are 4 other fully equipped bathing establishments. The springs are 3 in number, and designated as White Sulphur, Gardner (magnesic-calcic) and Eye Water Springs, which on analyses show the following mineralization:

SHARON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. E. Smith). White Sulphur Spring. | Gardner Spring. | Eye Water Spring. |
|---|---|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.7 | 0.4 | 0.4 |
| Potassium chloride (KCl) | 5.7 | 9.0 | 4.8 |
| Sodium chloride (NaCl) | 22.3 | 8.7 | 11.6 |
| Sodium sulphate ($NaSO_4$) | 116.1 | 115.8 | 56.9 |
| Magnesium sulphate ($MgSO_4$) | 971.7 | 299.5 | 340.0 |
| Calcium sulphate ($CaSO_4$) | 1063.7 | 1581.1 | 1472.3 |
| Calcium sulphite ($CaSO_3$) | 1.4 | 2.0 | 0.4 |
| Calcium hydrosulphide (CaHS) | 4.3 | 0.9 | 0.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 263.9 | 309.2 | 305.7 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | trace | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 5.3 | 5.0 | 4.4 |
| Silica($SiO_2$) | 4.7 | 10.5 | 8.4 |
| Total solids | 2469.8 | 2342.1 | 2205.1 |
| Gases, at 9° C. and 76° mm. pressure: | | | |
| Carbon dioxide, cc. per liter | 15.0 | 11.3 | 1.0 |
| Hydrogen sulphide, cc. per liter | 30.8 | 1.2 | 0.4 |

White Sulphur Spring, medicinal classification, sulphated or (S), sulphuretted. This is a moderately highly mineralized calcic, magnesic, sodic, sulphated alkaline-saline water, sulphuretted, flowing from the earth at the rate of 11,500 gallons per hour. It is of an agreeable temperature, 9° C. (48° F.), and free from the usual roughness which so often characterizes sulphur waters. The water is used both for drinking and bathing. It is highly recommended by the medical profession in rheumatic conditions, gouty and skin affections.

Gardner Spring, medicinal classification, sulphated (S). This is a

moderately highly mineralized, calcic, magnesic, sodic sulphated alkaline-saline water, carbon-dioxated, flowing about 11,000 gallons per hour. It is clear, bright, sparkling, of agreeable temperature, 9° C. (48° F.), pleasing to the palate and possessing gentle laxative action. It is indicated in digestive disorders and highly recommended in disturbances of the genito-urinary tract.

Eye Water Spring, medicinal classification, sulphated or (S). This is a moderately highly mineralized calcic magnesic sulphated alkaline-saline water. The use of this water for a number of years as a lotion for inflammatory conditions of the eye led to the appellation, Eye Water Spring.

Analyses show these waters to be sanitarily pure.

The bathing establishments are ornamental buildings, with separate sections for ladies and gentlemen; bath-houses are fitted with the latest modern equipment for administering, scientifically, all kinds of baths as given at the best European spas. (See also Chapter XV.)

## Glen Springs.

### (*Schuyler County.*)

*Postoffice,* Watkins. *Location,* in the southern tier of counties, in the middle section of the state of New York, west of Albany, the capital city, 200 miles. *Situation,* in the celebrated Finger Lake section of the state. This beautiful modern health resort and celebrated spa occupies a broad plateau, 300 feet above Seneca Lake, whose winding course it overlooks for nearly 30 miles. The Glen Springs estate, comprising 700 acres of woodland, farm and lawn, is surrounded by pine forests, backed by an amphitheatre of hills, rising in regular terraces to an elevation of 1500 feet. Just south of the springs, and within seven minutes' walk of the hotel, is the entrance to the famous Watkins Glen, one of the most picturesquely beautiful natural parks of the state of New York. *Access,* via the Pennsylvania Railway, the Lehigh Valley Railway and the New York Central Railway, also by Delaware, Lackawanna & Western Railroad and the Erie Railroad, connecting with the Pennsylvania Division at Elmira, N. Y., and by motor over splendid state highways. *Hotel,* there is a large commodious four-story brick and stucco structure of pleasing architectural design, luxuriously furnished and offering every convenience and comfort. The bathing establishment is modern, fitted with the latest approved apparatus for the scientific application of all forms of hydriatic treatment. The Nauheim baths are a special feature.

Nauheim Spring, medicinal classification, very strong saline 3 or (++Cl 3), strong radio-active. This is a very highly mineralized, sodic, calcic, potassic, magnesic, muriated, saline (bromic, iodic, ferruginous) water, radio-activated. This is a brine spring, originating

about 1600 feet below the earth's surface, similar in analysis to the Bad Nauheim, but about five times as strong. Prof. W. H. Thompson demonstrated that baths of this spring water are efficient in the treatment of glandular and rheumatic disorders; Dr. Schott, of Nauheim, proved them to be of great value in the treatment of disorders of the heart. This brine water is used in giving the Nauheim treatment and in many other baths, especially for rheumatic and kindred afflictions.

GLEN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Schwartz). | | | |
|---|---|---|---|---|
| | Nauheim Spring. | Deer Lick Spring. | Glen Kissengen Spring. | Salubria Spring. |
| Ammonium chloride ($NH_4Cl$) | 240.60 | 0.19 | 0.28 | 0.07 |
| Potassium chloride (KCl) | 17,520.00 | 133.30 | 93.72 | 416.10 |
| Sodium chloride (NaCl) | 85,340.00 | 1475.00 | 841.20 | 2309.00 |
| Magnesium chloride ($MgCl_2$) | 11,373.94 | 211.02 | 119.28 | 48.02 |
| Calcium chloride ($CaCl_2$) | 41,391.13 | | | |
| Lithium chloride (LiCl) | 34.71 | trace | ... | 0.07 |
| Magnesium sulphate ($MgSO_4$) | 14.42 | 4.20 | 5.71 | 14.27 |
| Sodium bromide (NaBr) | 2,007.00 | 5.08 | trace | 2.54 |
| Sodium iodide (NaI) | 3.31 | ... | trace | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | ... | 744.40 | 419.84 | 331.53 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 9.20 | 2.10 | | |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | | | | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 35.30 | 20.30 | 10.40 | 11.80 |
| Aluminum oxide ($Al_2O_3$) | 16.70 | 3.30 | 3.70 | 3.10 |
| Silica ($SiO_2$) | 8.90 | 7.80 | 7.20 | 15.20 |
| Phosphoric acid ($H_3PO_4$) | ... | trace | | |
| Total solids | 157,995.21 | 2606.59 | 1501.33 | 3151.70 |
| Radio-activity, mu. per liter | 73 | 2.8 | 2.2 | 0.7 |

Deer Lick Spring, medicinal classification, weak alkaline b2, saline or (−Ab2, Cl), weak radio-active. This is a moderately highly mineralized, potassic, sodic, magnesic, muriated and calcic bicarbonated, saline (bromic, ferruginous) water, radio-activated, possessing diuretic, aperient, tonic and alterative properties. This spring was known to the Indians as a "deer lick," and that the red men of the forest recognized its therapeutic value, was discovered, when excavations were being made, by finding log curbings built around it. This water resembles in many respects the waters of Kreuznach, Duerkheim and Krankenheil. Its use results in an improvement of the digestive processes, an increase in the flow of urine. These being the physiological effects of its use, it is recommended by authorities in gastro-intestinal disturbances, secondary anemia, chlorosis, neurasthenia, some diseases of women and also in chronic kidney disease. It has a wide reputation for its tonic and diuretic properties. The analysis shows the

predominating chemical constituents to be sufficiently diluted for drinking purposes. Many foreign waters of this class require dilution, since waters richer in salines than the blood stream must be diluted before using in order to avoid unfavorable results.

Glen Kissengen Spring, medicinal classification, weak alkaline b, weak saline 3 or (−Ab, −Cl 3), weak radio-active. This was discovered in 1907 through experimental drilling; at a depth of 150 feet a vein of water was pierced, which on analysis was found to be a moderately mineralized, sodic, potassic, magnesic, muriated and calcic, bicarbonated saline (ferruginous) water, radio-activated, possessing diuretic, aperient, tonic and alterative properties. Its action stimulates the secretions of the mucous membranes of the stomach, intestines, duodenum and biliary passages, and is useful in disorders requiring this stimulating action.

Salubria Spring, medicinal classification, saline or (Cl), very weak radio-active. This is a moderately highly mineralized, sodic, potassic muriated and calcic bicarbonated saline water, slightly radio-activated possessing diuretic, tonic and aperient properties. It is somewhat similar to the celebrated waters of Vichy, Tachingen and Bilin, but more like the waters of Kissengen, Homburg and Wiesbaden. This water exerts a stimulating action upon the mucous membranes of the stomach and intestines, increases the flow of gastric juice, augments hepatic function and promotes digestion and absorption. In medium doses it increases the process of osmosis, and in large doses exerts purgative action.

The Senega Spring is situated in the grounds, about 200 feet higher than the buildings, flowing at the rate of 100,000 gallons per day, and furnishes all the water for domestic use. It is a deliciously cool, pure, wholesome, potable water.

This was the first establishment in America to recognize the value of the Nauheim treatment and inaugurate its use; this fact associated with the Glen Springs has given it the appellation, the "American Nauheim." The Nauheim treatment includes the baths, exercises, rest, diet, the various accessory hydrotherapeutic, mechanotherapeutic and electrotherapeutic measures, together with the internal use of the mineral waters.

### Victor Mineral Spring.

(*Genesee County.*)

*Postoffice,* Darien Center. *Location,* in western New York; east of Buffalo, 25 miles; southwest of Rochester, 40 miles; south of Lyndonville, 40 miles. *Situation,* in a rolling region of country, at an elevation of about 1200 feet above sea level. *Access,* via the Erie Railway, thence by motor 1½ miles to the springs and via the New York Central lines, thence a distance of 5 miles by motor to the springs. *Hotel,* no accommodations at the springs, but good hotel at Darien Center, with

all modern conveniences. The analysis of the water shows the following mineralization:

VICTOR MINERAL SPRINGS.

| Hypothetical combinations | Parts per 1,000,000 (Analyst, H. M. Hill). |
|---|---|
| Lithium chloride (LiCl) | 103.40 |
| Sodium chloride (NaCl) | 5790.80 |
| Magnesium chloride ($MgCl_2$) | 50.50 |
| Potassium bromide (KBr) | 0.53 |
| Sodium bromide (NaBr) | 148.80 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.05 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 28.40 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1207.50 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 90.60 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 0.05 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 0.86 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.86 |
| Aluminum oxide ($Al_2O_3$) | 31.00 |
| Silica ($SiO_2$) | 2.10 |
| Total solids | 7455.47 |

Medicinal classification, weak alkaline b3, saline 3 or (−Ab3, Cl 3). The analysis shows this to be a highly mineralized, sodic, muriated and calcic, bicarbonated saline (strontic) water, possessing diuretic, antacid, tonic and alterative properties. The medical profession of Buffalo highly endorses this water in the treatment of disorders of the stomach due to acidity and hyperacidity. It exerts mild aperient action and relieves intestinal stasis. The bromide content is rather high and gives it a sedative action in all nervous and neurasthenic states. The late Dr. Roswell Park, of Buffalo, highly extolled the water as an ideal medicine for many chronic constitutional disorders.

The following places were once used as resorts:

*Adirondack Mineral Spring, P. O.*, Whitehall, Washington County. No definite information nor satisfactory analysis available.

*Ayer's Amherst Mineral Spring, P. O.*, Williamsville, Erie County. There are said to be 2 springs in this area, located 6 miles from Buffalo. The waters are said to possess laxative properties. No definite information nor satisfactory analysis available.

*Columbia Springs, P. O.*, Hudson, Columbia County. At one time this is said to have been a very pleasant, quiet resort, delightful air, amid a charming rural situation. The springs are 4 in number, saline-sulphur in character, carrying a considerable percentage of iron. No definite information nor satisfactory analysis available.

*Dansville Spring, P. O.*, Dansville, Livingston County. Repeated correspondence has failed to elicit any definite information concerning the class of waters. There is a very large establishment located here known as the Jackson Health Sanitarium, which is still a popular resort, but no definite information nor satisfactory analysis available.

*Doxtatter's Mineral Well, P. O.*, Rochester, Monroe County. This place is mentioned in some of the older works as Longmuir's Well. No definite information nor satisfactory analysis available. Postmaster returns correspondence marked "extinct."

*Dryden Springs, P. O.*, Dryden, Tompkins County. Location, on an elevated plateau overlooking the Catskill Range of mountains. At one time this is said to have been a very popular place of resort. A large and commodious hotel and sanitarium were once very popular, but at the present time no definite information nor satisfactory analysis available.

*Esperanza Mineral Springs, P. O.*, Penn Yan, Yates County. Location, is on the west branch of Lake Keuka. The waters are sulphuretted. No definite information nor satisfactory analysis available.

*Excelsior Springs, P. O.*, Syracuse, Onondaga County. No definite information nor satisfactory analysis available.

*Slaterville Magnetic Springs, P. O.*, Slaterville, Tompkins County. Location, 8 miles from Ithaca, in a charming valley, at an elevation of 2100 feet above sea level. There are 4 springs in this area, but no definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Arlington Spring, P. O.*, Arlington, Dutchess County.
*Biochemic Spring, P. O.*, Jamestown, Chautauqua County.
*Carrier Spring, P. O.*, Potsdam, St. Lawrence County.
*Cascade Spring, P. O.*, Grandview, Rockland County.
*Chemung Springs, P. O.*, Chemung, Chemung County.
*Chester Crest Spring, P. O.*, Mount Vernon, Westchester County.
*Clinton Lithia Springs, P. O.*, Kirkland, Oneida County.
*Crystalate Spring, P. O.*, Whitesboro, Oneida County.
*Eagle Spring, P. O.*, Danesville, Green County.
*Frontenac Crystal Springs, P. O.*, Clayton, Jefferson County.
*Glen Alex Springs, P. O.*, Washington Mills, Oneida County.
*Gramatan Springs, P. O.*, Bronxville, Westchester County.
*Granite Springs, P. O.*, Granite Springs, Westchester County.
*Great Bear Spring, P. O.*, South Granby, Oswego County.
*Greendale Crystal Spring, P. O.*, Livingston, Columbia County.
*Hides Franklin Mineral Spring, P. O.*, Ballston Spa, Saratoga County.
*Jubilee Spring, P. O.*, Buffalo, Erie County.
*Mammouth Spring, P. O.*, North Greenbush, Rensselaer County.
*Mohawk Spring, P. O.*, Amsterdam, Montgomery County.
*Morgan Spring, P. O.*, Rensselaer, Rensselaer County.
*Quaker Spring, P. O.*, West Sand Lake, Rensselaer County.
*Questover Spring, P. O.*, Moores Mill, Dutchess County.
*Risley Cold Springs, P. O.*, New York Mills, Oneida County.
*Sans Souci Spring, P. O.*, Ballston Spa, Saratoga County.
*Sparkling Spring, P. O.*, Buffalo, Erie County.
*Split Rock Lithia Spring, P. O.*, Kirkland, Oneida County.

*Standard Spring, P. O.*, Troy, Rensselaer County.
*Table Rock Mineral Spring, P. O.*, Mendon, Monroe County.
*Taconic Springs, P. O.*, Beacon, Dutchess County.
*Trespur Springs, P. O.*, McGraw, Cortland County.
*White Bear Spring, P. O.*, Stafford, Genesee County.

## NORTH CAROLINA.

North Carolina extends from 33°53′ to 36°33′ north latitude and from 75°25′ to 84°30′ west longitude, and comprises an area of 52,250 square miles, of which 3660 square miles are under water. The extreme length of the state is 503¼ miles and the greatest breadth is 187½ miles. Topographically, the state is divided into three distinct belts, the Appalachian Mountain region in the west, the Piedmont Plain in the middle and the coastal plain in the east, the dividing lines between these running obliquely across the state from southwest to northeast. The mountainous belt consists of a high plateau, covering about 6000 square miles and lying at an average elevation of from 2000 to 5000 feet. The Piedmont Plain is about 4000 feet above sea level; the coastal plain extends about 150 miles from the ocean, is level and sandy and the highest elevation is about 500 feet. The coast and swamp land extends about 100 miles inland; it is level and abounds in bogs and marshes; the Great Dismal Swamp is situated in the northern end of this boggy area, and extends into the state of Virginia. Fully 456¼ square acres are covered with swamps and bogs. The mountain region presents scenery of sublime and lofty grandeur, and is called the Land of the Sky, or the Switzerland of America. Mount Mitchell, 6700 feet in altitude, is the highest peak east of the Mississippi. The climate of the state is varied; in the mountainous sections the atmosphere is cool and dry, bracing and remarkably healthy; in the coastal section it is warm and humid. The mean annual temperature is 15° C. (58.52° F.); that of the summer, 25° C. (77.24° F.); of the winter, 4.4° C. (40.14° F.); in the extreme western part of the state the mercury often drops around the zero mark.

North Carolina has 77 spring localities, with a total of 175 individual springs, of which 19 have been analyzed and 33 at various times have been used as resorts (Peale). Walton mentions 5 spring localities; Crook mentions 11. The state has a large number of mineral springs, with a great variety of waters. The chalybeate and sulphuretted waters predominating; but there are numerous other varieties, calcic, saline, alkaline and one in particular is of interest containing arsenic. The state possesses one spring of unusual interest, Hot Springs, near the Tennessee line, it being the most highly thermic water east of the Rocky Mountains. The following account of the North Carolina springs is derived largely through the State Geologist and from personal investigation, from the printed literature on the subject and from personal correspondence with physicians and spring owners, and personal visitation.

## All Healing Springs.

(*Alexander County.*)

*Postoffice,* Taylorsville. *Location,* in the western portion of the state; west of Charlotte, 54 miles; north of Hickory, 25 miles; south of Wilkesborough, 25 miles. *Situation,* on the banks of a mountain creek, just at the foothills of the Brushy Mountains, at an elevation of 1300 feet above sea level. *Access,* via Taylors Depot, on the Southern Railway, thence by motor 6 miles to the springs. *Hotel,* there is a small hotel, with conveniences for entertaining guests. The analysis of the water shows the following mineralization:

ALL HEALING SPRINGS.

| Hypotheticalc ombinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). |
|---|---|
| Sodium chloride ($NaCl$) | 6.5 |
| Sodium sulphate ($Na_2SO_4$) | 8.5 |
| Potassium sulphate ($K_2SO_4$) | 4.8 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 4.6 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 10.9 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 66.2 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.2 |
| Silica ($SiO_2$) | 25.2 |
| Total solids | 128.9 |

This spring is a lightly mineralized, calcic, magnesic, bicarbonated alkaline water. It flows at the rate of 120 gallons per hour, with a temperature of 14.8° C. (58.6° F.). The water is pleasant to the taste, sparkling as it comes from the spring. It has been found of value in the treatment of rheumatic affections of the joints, and in certain disorders of the kidneys. It is also of value in impoverished conditions of the blood where an iron tonic is indicated.

## Barium Springs.

(*Iredell County.*)

*Postoffice,* Barium Springs. *Location,* in the famous Piedmont section of the state; south of Statesville, 5 miles; north of Charlotte, 40 miles; west of Salisbury, 30 miles; east of Hickory, 25 miles. *Situation;* it nestles atop a rocky knoll, about 15 feet higher than a mountain brook that goes rippling along; not 40 feet away. There are 8 other springs, located around the base of this knoll and 100 feet distant from Barium Rock Spring. This spring was discovered in 1775; it was formerly known as Poison Spring, from the fact that cattle would not drink the water. *Access,* via Barium Springs Station, on the Winston &

Salem Division of the Southern Railway, thence ½ mile to the spring. *Hotel*, there is a comfortable hotel, with modern conveniences. There are 9 springs in the group; of these the Barium Rock Spring is the most valuable from a medicinal point of view, and the most popular. We present an analysis of this spring, which flows at the rate of about 2000 gallons daily. The basin for catching the water is cut in the solid rock just below the spring, and this has a capacity of 375 gallons daily.

BARIUM SPRINGS.

| Hypothetical combination. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). |
|---|---|
| Sodium chloride (NaCl) | 10.3 |
| Sodium sulphate ($Na_2SO_4$) | 9.9 |
| Potassium sulphate ($K_2SO_4$) | 7.0 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 10.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 7.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 115.1 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.1 |
| Silica ($SiO_2$) | 31.8 |
| Total solids | 202.5 |

A qualitative analysis was made of the following springs, Chalybeate, White Sulphur and Red Sulphur; the remaining ones have not been examined.

Chalybeate Spring was tested by W. A. Withers, of the North Carolina Department of Agriculture, and gave: Total solids, 122.12 parts per 1,000,000. It showed the presence of: Soda ($Na_2O$), potash ($K_2O$), magnesia (MgO), calcium (CaO), iron oxide ($Fe_2O_3$), chlorine (Cl) and carbon dioxide ($CO_2$).

White Sulphur Spring was also tested by W. A. Withers, of the State Department of Agriculture, and gave: Total solids, 179.55 parts per 1,000,000. It showed the presence of: Soda ($Na_2O$), potash ($K_2O$), magnesia (MgO), calcium (CaO), iron oxide ($Fe_2O_3$), chlorine (Cl), sulphuric oxide ($SO_3$) and carbonic acid ($CO_2$).

Red Sulphur Spring, tested by W. A. Withers, gave: Total solids, 177.84 parts per 1,000,000. It showed the presence of: Soda ($Na_2O$), potash ($K_2O$), magnesia (MgO), calcium (CaO), iron oxide ($Fe_2O_3$), chlorine (Cl), sulphuric oxide ($SO_3$) and carbon dioxide ($CO_2$).

Barium Rock Spring is a lightly mineralized, calcic, sodic bicarbonated, alkaline water, possessing diuretic, tonic, alterative properties. Its virtues have been extolled by the profession in the treatment of irritable states of the lymphatic system and in eczematous affections. According to Indian legends, this is another of the springs of the state whose discovery is attributed to the red men, who are said to have recognized its curative virtues and made pilgrimages to it.

## Bromine Arsenic Spring.

(*Ashe County.*)

*Postoffice*, Crumpler. *Location*, in the extreme northwest corner of the state; south of Chilhowie, Va., 39 miles; east of Bristol, Tenn., 34 miles; east of Mountain City, Tenn., 15 miles; west of Mount Airy, 40 miles; north of the celebrated Blowing Rock, 30 miles. *Situation*, at the foothills of the western slope of the Blue Ridge Mountains, amid a rugged, wild picturesque region, with an elevation of 2725 feet above sea level. *Access*, via Southern Railway to Mountain City, Tenn., thence by motor 15 miles to the springs, through a wonderfully picturesque region, full of natural scenic beauty and primeval charm. *Hotel*, there is a comfortable hotel, with modern conveniences. The spring flows at the rate of 1500 gallons daily. The analysis below shows the mineralization to be moderate:

BROMINE ARSENIC SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood, U. S. Dept. Agr., Bull. No. 91). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.12 |
| Lithium chloride ($LiCl$) | trace |
| Potassium chloride ($KCl$) | 5.20 |
| Sodium chloride ($NaCl$) | 2.30 |
| Potassium bromide ($KBr$) | trace |
| Sodium sulphate ($Na_2SO_4$) | 9.00 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium nitrate ($NaNO_3$) | 4.85 |
| Sodium nitrite ($NaNO_2$) | trace |
| Sodium arseniate ($Na_2HAsO_4$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 65.50 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 13.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 28.40 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.20 |
| Silica ($SiO_2$) | 62.60 |
| Total solids | 192.37 |

This is a lightly mineralized, sodic, calcic, bicarbonated alkaline, (bromic, arsenic) water, carbon-dioxated. This water is unique in possessing appreciable quantities of the rare chemical elements—the arsenite of sodium and the iodide and bromide of sodium; there is also appreciable amounts of the carbonate of lithium and the carbonate of iron. The water possesses mild antacid, tonic and alterative properties, and has been found useful in many of the affections benefited by this class of waters.

### Buckhorn Lithia Springs.

(*Granville County.*)

*Postoffice*, Bullock, via Oxford. *Location*, in the north central portion of the state, about 5 miles south of the North Carolina and Virginia boundary line; north of Raleigh, the capital city, 55 miles; east of Mount Airy, 120 miles; south of the celebrated Buffalo Lithia Springs, Va., about 20 miles. *Situation*, on the side of a high hill, about 500 feet above tide water and 50 feet above the bed of a stream which flows at the foot of this hill. *Access*, via Bullock Station, on the Richmond, Keysville & Durham Division of the Southern Railway System, thence by motor 1 mile to the springs. *Hotel*, there is no hotel, but a very large and commodious southern colonial home accepts guests who desire to use the water at the springs. The analysis below shows the mineralization of the water.

BUCKHORN LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, D. L. Liddell). |
|---|---|
| Potassium chloride (KCl) | 1.02 |
| Sodium chloride (NaCl) | 10.43 |
| Sodium sulphate ($Na_2SO_4$) | 5.81 |
| Sodium bicarbonate ($NaHCO_3$) | 6.50 |
| Lithium bicarbonate ($LiHCO_3$) | 80.58 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 43.96 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 165.96 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 3.08 |
| Silica ($SiO_2$) | 27.37 |
| Total solids | 343.71 |
| Flow in gallons per day | 2160 |
| Temperature, °C. | 12.2 |

The analysis shows this to be a lightly mineralized, calcic, lithic, bicarbonated alkaline water, possessing diuretic, antacid, antilithic and tonic properties. This water ought to be valuable in the treatment of gastric disturbances due to acidity and in irritable conditions of the genito-urinary system, renal and vesical calculi, etc. The iron content gives it tonic properties indicated in anemia and chlorosis. The waters are bottled and shipped extensively. According to the North Carolina Geological Reports, more water was sold from this spring than from any area in the state. The situation is admirable for a large health resort.

### Cleveland Springs.

(*Cleveland County.*)

*Postoffice*, Cleveland Springs, Shelby Park. *Location*, in the western part of the state, at the foothills of the Blue Ridge Mountains;

west of Charlotte, 50 miles. *Situation*, in the western edge of the far-famed Piedmont section of the state, near a magnificent mountain gorge. *Access*, via the Seaboard Air Line Railway and the Southern Railway to Shelby, thence by motor 2 miles to the springs; or by motor over North Carolina's wonderful highways, connecting the great national highways. *Hotel*, there is a modern resort hotel at Cleveland Springs. There are 3 springs gushing forth from the mountain side, which were revered as "medicine waters" by the Indians before the advent of the white man. More than a century ago the early settlers learned of their health-giving properties and made long journeys, braving dangers to partake of the waters. The following analyses show their mineralization:

CLEVELAND SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). White Sulphur Spring. | Red Sulphur Spring. | Iron Spring. |
|---|---|---|---|
| Sodium chloride (NaCl) | 22.4 | 8.2 | 11.5 |
| Sodium sulphate ($Na_2SO_4$) | ... | 2.3 | |
| Potassium sulphate ($K_2SO_4$) | 4.7 | 7.2 | 6.5 |
| Calcium sulphate ($CaSO_4$) | 4.9 | | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | ... | trace | |
| Sodium bicarbonate ($NaHCO_3$) | ... | 6.5 | |
| Magnesuim bicarbonate ($Mg[HCO_3]_2$) | 26.7 | 16.4 | 16.4 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 84.4 | 67.2 | 24.9 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.3 | 2.6 | 31.8 |
| Manganous bicarbonate ($Mn[HCO_3]_2$) | trace | trace | 7.3 |
| Silica ($SiO_2$) | 31.0 | 25.3 | 27.9 |
| Total solids | 177.4 | 135.7 | 126.3 |

White Sulphur Spring is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline-saline water, sulphuretted, possessing diuretic, tonic and very slight laxative action.

Red Sulphur Spring is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline-saline water, sulphuretted, possessing diuretic, tonic and slight laxative action.

Iron Spring is a lightly mineralized, ferruginous, calcic, bicarbonated alkaline-saline (manganous) water, possessing tonic and alterative properties.

These waters are highly endorsed in the treatment of various digestive disturbances, diseases of the liver and gall ducts, rheumatism, gout and diabetes. The Iron Spring is a valuable tonic where there is impoverished condition of the blood and the blood-making organs. Cleveland Springs has long been an all-year-round resort.

## Connelly Springs.

(*Burke County.*)

*Postoffice*, Connelly Springs. *Location*, in the western Piedmont section of the state; east of Asheville, 74 miles; west of Salisbury, 67 miles. *Situation*, at the foothills of the Blue Ridge Mountains, in a

beautiful picturesque region, full of natural charm. To the westward can be seen the Majestic Black Mountains, on and beyond; Mount Mitchell stands out in all its glory against the deep azure of the sky line. *Access*, via the main line of the Southern Railway to Connelly Station, thence only a short distance to the springs. *Hotel*, there is a commodious building equipped with modern conveniences. The spring is well improved and enclosed in a marble basin. The water is clear and sparkling, but has a metallic taste, due to the iron which is an important element of the water.

CONNELLY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). |
|---|---|
| Sodium chloride (NaCl) | 2.7 |
| Potassium chloride (KCl) | 1.1 |
| Potassium sulphate ($K_2SO_4$) | 1.1 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 26.0 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 16.0 |
| Silica ($SiO_2$) | 4.8 |
| Total solids | 54.3 |

This is a slightly mineralized, calcic, ferric, bicarbonated alkaline water, possessing diuretic and slight tonic properties. This place has long been a popular resort and has enjoyed a liberal patronage. Many of the best families of the section sojourn there for several weeks during the summer season.

## Davis White Sulphur Spring.

(*Alexander County.*)

*Postoffice*, Hiddenite. *Location*, in the western Piedmont section of the state; northwest of Charlotte, 59 miles; west of Greensboro, 70 miles; southeast of Blowing Rock, 30 miles. *Situation*, near the bank of Davis Creek, at the base of a hill of 1100 feet elevation, one of the outlying spurs of the Brushy Mountain Range. *Access*, via the Taylorsville Branch of the Southern Railway to Hiddenite, thence $1\frac{1}{2}$ miles to the spring. *Hotel*, there is a comfortable and commodious hostelry, with modern conveniences. The analysis given below shows the mineralization of the spring:

DAVIS WHITE SULPHUR SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). |
|---|---|
| Sodium chloride (NaCl) | 6.3 |
| Sodium sulphate ($Na_2SO_4$) | 2.5 |
| Potassium sulphate ($K_2SO_4$) | 7.9 |
| Calcium phosphate ($Ca_3PO_4$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 160.4 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 8.4 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 9.5 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.9 |
| Silica ($SiO_2$) | 20.0 |
| Total solids | 217.9 |

This is lightly mineralized, sodic, bicarbonated, alkaline water, sulphuretted. It is a sulphur water of exceptional purity, possessing decided therapeutic properties. The spring flows at the rate of about 2000 gallons daily, and has a strong taste and odor of hydrogen sulphide and bubbles of gas can be seen escaping from the water. This spring has been known of for more than a hundred years, and has been used locally for several decades. The profession recommend it in conditions benefited by a sulphur water. A resident physician is in attendance. Long-distance telephone and telegraph facilities in the hotel office.

### Elerbe Springs.

*(Richmond County.)*

*Postoffice,* Rockingham. *Location,* in the southern portion of the state; only a few miles north of the South Carolina line; north of Rockingham, 7 miles; west of Pinehurst, 24 miles. *Situation,* in a beautiful rolling country, at the foot of a high hill, on the south side of a rippling creek hurrying to get down hill. *Access,* via Norfolk & Southern Railway to Elerbe, the terminus of a line from Pinehurst; Seaboard Air Line Railway and Southern Railway to Rockingham, thence by motor 7 miles to the springs. *Hotel,* there is a commodious, comfortable hotel, with some conveniences. There are 2 springs, 1 of which we append herewith the analysis, and the other a sulphur spring which has not been analyzed.

ELERBE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). |
|---|---|
| Sodium chloride ($NaCl$) | 10.2 |
| Potassium sulphate ($K_2SO_4$) | 3.7 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.6 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 27.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 59.8 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 8.8 |
| Manganous bicarbonate ($Mn[HCO_3]_2$) | 2.3 |
| Silica ($SiO_2$) | 29.6 |
| Total solids | 142.7 |

The spring is enclosed with masonry; the water forms in the outflow a reddish-brown flocculent deposit. The water is heavily charged with carbon-dioxide gas, which can be seen in bubbles escaping. The flow of the spring is about 1500 gallons in twenty-four hours. It is a lightly mineralized, calcic, magnesic, bicarbonated alkaline (manganic) water, carbon-dioxated, possessing diuretic, tonic, alterative and restorative properties. It will be found useful in anemia, chlorosis and leukocythemia. In liberal dosage, 10 to 12 glasses daily, it should be advantageous in digestive disturbances due to acidity. The water is not shipped commercially. The place is a resort for the summer months only.

## Haywood White Sulphur Springs.

(*Haywood County.*)

*Postoffice*, Waynesville. *Location*, in the western part of the state, in the heart of the Allegheny Mountains; west of Asheville, 35 miles; south of the celebrated North Carolina Hot Springs, about 30 miles; west of Waynesville, 1 mile. *Situation*, at foot of the Great Balsam Mountains, with an elevation of 2850 feet above sea level. The climate is dry, healthful and salubrious. *Access*, via the Murphy Division of the Southern Railway from Asheville to Waynesville, thence by motor 1 mile to the springs. *Hotel*, this is a large commodious brick structure, equipped with all modern conveniences for the accommodations of guests, besides several cottages furnish additional accommodations. There are 2 springs, the Haywood White Sulphur and the Haywood Chalybeate, the latter is situated at the rear of the hotel, about 1 mile distant from the White Sulphur. We give the analyses of both springs:

HAYWOOD WHITE SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). White Sulphur Spring. | Chalybeate Spring. |
|---|---|---|
| Sodium chloride (NaCl) | 9.5 | 10.8 |
| Calcium chloride ($CaCl_2$) | ... | 1.4 |
| Sodium sulphate ($Na_2SO_4$) | 9.80 | |
| Potassium sulphate ($K_2SO_4$) | 3.60 | 5.3 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 9.50 | 22.3 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 4.93 | 50.5 |
| Lithium bicarbonate ($LiHCO_3$) | trace | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.10 | 727.3 |
| Hydrogen sulphide ($H_2S$) | undet. | |
| Silica ($SiO_2$) | 23.5 | 134.8 |
| Total solids | 61.93 | 952.4 |

Haywood White Sulphur Spring is a slightly mineralized, magnesic, calcic, bicarbonated alkaline-saline water, sulphuretted, possessing diuretic properties, and has been used with success in the treatment of chronic functional disturbances of the gastro-intestinal tract, liver and kidneys; rheumatism and neuralgic troubles are benefited by the hot sulphur baths.

Haywood Chalybeate Spring, is a moderately mineralized, ferric, bicarbonated alkaline water, possessing diuretic, tonic and alterative properties. This water contains iron bicarbonate 727.3 parts per 1,000,000, while the celebrated steel spring at Pyrmont, Germany, contains 53.00 parts per 1,000,000 of this element. The Haywood Chalybeate Spring water is a very valuable tonic water, indicated in all depraved conditions of the blood and blood-making organs, par-

ticularly in anemia, chlorosis and leukocythemia and malnutrition from disordered metabolism.

## Hot Springs.

(*Madison County.*)

*Postoffice*, Hot Springs. *Location*, 3 miles east of the North Carolina and Tennessee boundary line; west of Raleigh, the capital city, 311 miles; west of Greensboro, 230 miles; northwest of Asheville, 40 miles; east of Memphis, Tenn., 400 miles. *Situation*, in the heart of the Blue Ridge and Big Smoky Mountains, on the banks of the French Broad River, at an elevation of 2000 feet above sea level; surrounded on all sides by precipitous mountains, save the gorge and valley, where the French Broad River has worn its pathway. The mighty glacier which once went grinding, crushing and cutting its way down, forming the bed of this romantic mountainous stream, has written its record deep in the granite faces of the majestic mountains, which looked down in solitary silence upon the terrific devastating forces of Nature, still revealed in the massive giant boulders piled upon their sides and in the scratched or polished surfaces of stone strewn along the bed of this mighty turbulent stream, but today there is no suggestion of the chaos and desolation of those days of the birth of this rough and rugged region of mountain fastness, with its varied scenes of natural beauty and weird grandeur. This beautiful, picturesque panorama of precipitous mountains, rugged hills, stony cliffs and mountain fastness presents scenic vistas unexcelled in any section of this country. There are some 43 peaks in this region, whose pinnacles exceed 6000 feet in altitude, comprising the most stupendous mountain grandeur east of the great Rocky Mountains, some of which present a sheer perpendicular of naked rock, 1800 feet in height; otherwise the mountains are covered with a deep soil and clothed with massive forests to their tops. *Access*, via the Southern Railway, which delivers passengers (through trains from the north, south, east and west) to the station within the grounds. *Hotel*, occupying a tableland some 40 feet higher, and on the banks of the French Broad River, sits the Mountain Park Hotel, a modern resort caravansary, with all metropolitan conveniences; large airy rooms, spacious halls and broad verandas, overlooking the beautiful French Broad River. There is a modern bathing establishment, complete in its equipment, ornate in design, luxurious in its conveniences. The scenery surrounding the beautifully landscaped park, in the midst of which is situated the springs and hotel, is so charming that it is often given the appellation, the "Switzerland of America." During the World War the Federal Government took over the property and used it as a camp to intern officers who were enemy prisoners of war. There are some 20 or more hot springs in this area, ranging in temperature from 30° C. (96° F.)

to 40° C. (104° F.). They form one of only two groups of thermic springs east of the Mississippi. The analyses below show the mineralization of a few of these thermic springs:

HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analyst, Chandler & Pellew. | | Analyst, Prof. E. Adelmarth. | |
| | Bathing Spring. | Drinking Spring. | Warm Spring. | Hot Spring. |
| Potassium chloride (KCl) | 5.30 | 8.56 | | |
| Sodium chloride (NaCl) | 15.57 | 18.82 | 40.09 | |
| Magnesium chloride ($MgCl_2$) | 3.76 | 6.33 | ... | 34.08 |
| Calcium chloride ($CaCl_2$) | 170.81 | 152.96 | 195.42 | 51.47 |
| Potassium sulphate ($K_2SO_4$) | 6.16 | 0.04 | | |
| Sodium sulphate ($Na_2SO_4$) | 154.50 | 152.27 | 72.55 | |
| Magnesium sulphate ($MgSO_4$) | 22.93 | 139.10 | 130.72 | 128.33 |
| Calcium sulphate ($CaSO_4$) | 699.46 | 693.63 | ... | 300.45 |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 102.00 | |
| Ferric oxide ($Fe_2O_3$) | ... | ... | 40.03 | |
| Sodium silicate ($Na_2SiO_3$) | 51.16 | 54.40 | | |
| Calcium silicate ($CaSiO_3$) | 102.32 | 108.82 | | |
| Silica ($SiO_2$) | ... | ... | 65.36 | |
| Total solids | 1231.97 | 1342.93 | 647.17 | 514.33 |
| Temperature, °C. | 30 | 32.8 | 36.2 | 40 |

Bathing Spring, medicinal classification, weak calcic sulphated 2 or (−CaS2). This is a moderately mineralized, thermic, calcic, sulphated and muriated saline (potassic) water, sulphuretted.

Drinking Spring, medicinal classification, weak calcic sulphated 2 or (−CaS2). This is a moderately mineralized, thermic, calcic, sulphated and muriated saline (potassic) water, sulphuretted.

Warm Spring, medicinal classification, weak total mineralization 2 or (−T2). This is a moderately mineralized, thermic, sodic bicarbonated and muriated alkaline-saline water, carbon-dioxated.

Hot Spring, medicinal classification, weak calcic sulphated or (−CaS), thermic. This is a moderately mineralized, thermic, calcic and magnesic sulphated saline water, sulphuretted.

In the past these waters have had quite a reputation in the treatment of diseases of a chronic nature, rheumatism and arthritic joint disturbances, chronic skin diseases and in disorders of the gastro-intestinal tract, diseases of the liver and gall ducts. The hot baths administered here afford relief in many cases which have resisted the therapeutic effects of the ordinary galenical medicines. With the delightful mountain scenery, its exhilarating climate, its thermic

waters, combined with a hospitable and scientific management, this resort ought to be come one the great spas of the country.

Since this was written we learn that the hotel buildings have been destroyed by fire.

## Jackson Springs.

(*Moore County.*)

*Postoffice*, Jackson Springs. *Location*, near the center of the state; south of Greensborough, 60 miles; southwest of Raleigh, the capital city, 50 miles; west of Pinehurst, 11 miles; north of Rockingham, 30 miles. *Situation*, in the long-leaf pine section of the state, in a gently rolling section of country, immediately surrounded by a beautiful park, heavily wooded with majestic oak, pine and hickory trees, and covering an area of 800 acres. *Access*, via the Asheboro & Aberdeen Division of the Southern Railway to Jackson Station, thence only a short distance to the springs. *Hotel*, there is a modern three-story building of pleasing architectural design, with accommodations for 100 guests. While the therapeutic properties of the Jackson Spring water have long been known and appreciated, it was not until 1890 that a hotel was erected, which was filled to overflowing the first season. The following is the analysis of the water:

JACKSON SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). |
|---|---|
| Sodium chloride ($NaCl$) | 11.2 |
| Sodium sulphate ($Na_2SO_4$) | 8.5 |
| Potassium sulphate ($K_2SO_4$) | 4.8 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 8.7 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 24.1 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 45.8 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 11.3 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 6.4 |
| Silica ($SiO_2$) | 39.2 |
| Total solids | 180.0 |

This is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline (manganic) water, possessing diuretic and tonic properties. The water is highly endorsed by the local profession in digestive disorders, bladder and kidney affections. Jackson Springs has become attractive to tourists and pleasure seekers, and beyond question the place offers health-giving advantages, with rest and pleasure. The waters are bottled and shipped commercially over a large area of this and adjoining states.

## Lincoln Lithia Springs.

*(Lincoln County.)*

*Postoffice*, Lincolnton. *Location*, in the western Piedmont section of the state; northwest of Charlotte, 35 miles; north of Gastonia, 30 miles; south of Hickory, 20 miles; east of Asheville, 85 miles; 2 miles from Lincolnton. *Situation*, in a dimple made by the smile of Nature, 1200 feet above sea level, and tucked away in one of the most charming and delightful spots in the famous "Land of the Sky;" a playground of Nature's own handiwork, beautified through the skill of a landscape artist, green rolling lawns interspersed with perennial flowers, shaded with the majestic oak, stately hickory and other indigenous trees. The climate is mild, equable and salubrious, never reaching the extremes of heat and cold. *Access*, via Lincolnton Depot, on the Seaboard Air Line Railway and the Carolina & Western Railway, thence 2 miles to the springs, over a graded macadam highway, leading through a picturesque region, with every turn of the road presenting vistas of sublime scenic interest. *Hotel*, there is a modern hostelry, with metropolitan conveniences. The swimming pool is an attraction and contributes much to the pleasure of guests. Adequate provisions for dressing-room accommodations in the bath-house. The analysis shows the following mineralization:

LINCOLN LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). |
|---|---|
| Sodium chloride ($NaCl$) | 14.01 |
| Potassium sulphate ($K_2SO_4$) | 14.21 |
| Calcium sulphate ($CaSO_4$) | 12.71 |
| Sodium phosphate ($Na_2HPO_4$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 2.47 |
| Lithium bicarbonate ($LiHCO_3$) | 33.60 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 8.15 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 76.36 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.67 |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silica ($SiO_2$) | 7.80 |
| Total solids | 174.12 |

This is a lightly mineralized, calcic, lithic, bicarbonated, alkaline water, flowing at the rate of 1440 gallons daily, with a temperature of 15.6° C. (60° F.); possessing diuretic, antacid and tonic properties. This water is highly endorsed by the profession in the treatment of bladder and kidney affections and in disturbances of the digestive tract due to acidity; this water, with its predominating bicarbonate chemical constituents and the free carbonic-acid gas in solution, has been used with the most pleasing results in irritations of the genito-urinary tract. The liberal lithia content of this bicarbonated alkaline

water readily attacks uric acid and converts it into the urate of lithia, which is easily and readily excreted. It also possesses valuable tonic properties and contains the bicarbonate of iron in almost the exact amount as the famous steel spring at Pyrmont, Germany, which is a noted resort on account of its tonic waters. These waters are valuable in the uric-acid diathesis, rheumatism, gout and allied diseases.

## Moore's Springs.

(*Stokes County.*)

*Postoffice,* Moore's Springs. *Location,* in the western Piedmont section of the state; northwest of Greensboro, 40 miles; east of Mt. Airy, 30 miles; north of Winston-Salem, 25 miles. *Situation,* among the foothills of the Saura Town Mountains, out-cropping ranges from the Blue Ridge Mountains to the westward. The springs issue from gneiss and granite bedrock in a beautiful setting, 1000 feet above sea level. The sentinel of that section of the country is Pilot Mountain, a notable monarch of this region lifting its pinnacle 3000 feet in altitude. *Access,* via Rural Hall Station, on the Southern Railway, thence by motor over a splendid mountain highway, through a picturesque mountain region, 15 miles to the springs. *Hotel,* Moore's Springs Hotel is a typical resort hostelry, furnishing fair accommodations for 250 summer guests. The climate is salubrious, invigorating and bracing. The waters of Moore's Springs, which have been known of and used medicinally for more than half a century, on analysis show the following mineralization:

MOORE'S SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, F. A. Genth, Jr.). Spring No. 1. | Spring No. 2. |
|---|---|---|
| Sodium chloride ($NaCl$) | 7.53 | 6.50 |
| Sodium sulphate ($Na_2SO_4$) | 47.07 | 43.82 |
| Potassium sulphate ($K_2SO_4$) | 30.47 | 23.54 |
| Magnesium sulphate ($MgSO_4$) | 94.15 | 83.74 |
| Calcium sulphate ($CaSO_4$) | 1445.95 | 1453.66 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 69.67 | 78.74 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 5.14 | 5.47 |
| Cupric oxide ($CuO$) | 1.37 | 1.22 |
| Aluminum oxide ($Al_2O_3$) | trace | trace |
| Lithium oxide ($LiO$) | trace | trace |
| Silica ($SiO_2$) | 22.25 | 28.24 |
| Total solids | 1723.60 | 1724.93 |

Spring No. 1 and Spring No. 2, medicinal classification, weak calcic sulphated 4 or (−CaS4). The combined flow of these springs is about 1000 gallons each per day. A careful comparative examination of the analyses shows that the predominating chemical constituents are very

similar, so much so that both springs can be classed as a moderately mineralized, calcic, sulphated, saline water, possessing antacid, diuretic and tonic properties. The waters are highly endorsed by the profession in the treatment of digestive disturbances due to acidity, in catarrhal disorders of the intestinal tract, in irritable states of the genito-urinary tract and in rheumatic disturbances, both acute and chronic. This water is a valuable tonic, especially in anemic conditions of young girls just budding into womanhood. The iron and copper are present in sufficient quantities and in the most assimilable form for an alterative and revitalizing tonic. The waters are bottled and shipped extensively throughout the surrounding country. Resident physicians. Long-distance telephone and telegraph facilities.

## Mount Vernon Springs.

*(Chatham County.)*

*Postoffice*, Mount Vernon Springs, via Ore Hill. *Location*, in the celebrated Piedmont section of the state, and not far from the center of the commonwealth. *Situation*, in a beautiful little vale, lying between two hills amid a scene of great natural beauty, surrounded by a picturesque panorama of hills and dales, which completely enclose the park in a sylvian-like retreat, resting some 500 feet above sea level. The hotel sits atop a high plateau in the midst of a magnificent grove of stately oak, sturdy hickory, majestic pine and poplar, through which wind shaded graveled walks and splendid macadam driveways. *Access*, via Ore Hill Station, on the Southern Railway, thence 1 mile to the springs, or via motor over the finest highways to be found in the entire South. *Hotel*, a comfortable and commodious home-like structure, with accommodations for about 100 guests. There are a number of springs in the area, Springs No. 1, 2, 3 and 4. We give the analyses of 2 of the more important, which show the mineralization:

MOUNT VERNON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). Spring No. 2. | Spring No. 3. |
|---|---|---|
| Sodium chloride ($NaCl$) | 4.60 | 30.0 |
| Potassium chloride ($KCl$) | 14.70 | - |
| Potassium sulphate ($K_2SO_4$) | 2.56 | 0.6 |
| Sodium sulphate ($Na_2SO_4$) | 10.25 | 4.6 |
| Calcium sulphate ($CaSO_4$) | ... | 138.2 |
| Sodium bicarbonate ($NaHCO_3$) | 17.50 | |
| Magnesium bicarbonate ($Mg[CHO_3]_2$) | 15.79 | 24.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 29.08 | 299.3 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 1.8 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 14.02 | |
| Silica ($SiO_2$) | 10.08 | 25.4 |
| Total solids | 118.58 | 523.9 |

The analysis shows Spring No. 2 to be a lightly mineralized, calcic, sodic, bicarbonated and potassic muriated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, tonic and alterative properties.

Spring No. 3, medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, calcic bicarbonated and sulphated, alkaline water, carbon-dioxated, possessing diuretic, antacid and slight tonic properties. The waters from both springs issue from the bosom of Mother Nature, sparkling with natural carbonic-acid gas, very palatable, cooling and refreshing. There is considerable Indian legends and lore connected with the history of the springs, and of their resorting at the spring which gave the "waters of life," and of bringing their ill or wounded here to be restored to health. The red men called the spring "waters of life," and at various times since the springs have born the following appelations: Indian Springs, Physic Springs and Hickory Springs, and finally, in 1852, the place was called Mount Vernon Springs, and since that date has been open to the public for the summer seasons. The waters are highly endorsed by the local profession, and have given great satisfaction in the treatment of disorders of the gastro-intestinal tract and in diseases of the kidneys and bladder. The waters exert decided diuretic properties.

## Panacea Springs.

(*Warren County.*)

*Postoffice,* Littleton. *Location,* in the northern tier of counties, bordering the southern Virginia boundary line; north of Goldsborough, 105 miles; northeast of Raleigh, the capital city, 77 miles; south of Littleton, 3 miles. *Situation,* in a charming valley, surrounded by a picturesque region, 476 feet above sea level. *Access,* via the Seaboard Air Line Railway to Littleton, thence 3 miles by motor to the springs, through a beautiful picturesque region, each turn of the road presenting a panorama to delight the eye. *Hotel,* the New Panacea Hotel is a modern hostelry, commodious and fitted with all modern conveniences. The springs number about 40 all told, many of which are under the lake, which covers about 40 acres of land. We give herewith the analysis of 1 of the important springs.

PANACEA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Samuel P. Stadler). |
|---|---|
| Potassium chloride (KCl) | 5.66 |
| Sodium chloride (NaCl) | 1.11 |
| Sodium sulphate ($Na_2SO_4$) | 3.33 |
| Potassium sulphate ($K_2SO_4$) | |
| Sodium bicarbonate ($NaHCO_3$) | 54.78 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 33.86 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 48.58 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 50.16 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 12.22 |
| Aluminum oxide ($Al_2O_3$) | 0.99 |
| Silica ($SiO_2$) | 18.35 |
| Total solids | 229.00 |

Medicinal classification, very weak manganese-ferruginous or (− −Mn Fe). This is a lightly mineralized, ferric, sodic, calcic, bicarbonated alkaline water, carbon-dioxated, possessing decided tonic, alterative and diuretic properties. The action increases the hemoglobin content of the blood, stimulates the appetite, increases weight and is indicated wherever there is a depleted condition of the red coloring matter of the blood. Such waters give excellent results when used as a tonic; the alterative action is augmented by the bicarbonate of manganese with which it is combined in solution in the water. This water is highly endorsed by the profession in diseased conditions in which a tonic and alterative medicine is indicated. Excellent results have been obtained in the treatment of anemic, chlorotic and constitutional ailments, diseases of metabolism due to mal-assimilation, skin diseases and scrofula. The Indians, centuries before the white man, frequented this spring, to whom it was "medicine water." (See also Chapter XV.)

### Seven Springs.

*(Wayne County.)*

*Postoffice*, Seven Springs. *Location*, in the Coastal Plain region of the state; west of Kinston, 15 miles; southeast of Goldsborough, 10 miles; northwest of Newberne, 40 miles. *Situation*, on a terrace 200 yards wide, overlooking the Neuse River, and just above the high-water mark of freshets. *Access*, via La Grange Station, on the Atlantic & North Carolina Railway, thence 9 miles by motor to the springs; via the splendid highways, which the state maintains all over this section, the best macadam roads in the whole country. *Hotel*, the hotel is situated on the upper terrace, overlooking the springs and the majestic old Neuse River lazily wending its way into Pamlico Sound, on the coast. The springs, 7 in number, all burst through the earth's crust within an area of 20 square feet. The analyses below show the mineralization of 6 of the springs:

SEVEN SPRINGS.

| | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 5. | Spring No. 6. |
| Sodium chloride (NaCl) | 8.9 | 7.6 | 11.5 | 7.9 | 6.9 | 7.6 |
| Potassium sulphate ($K_2SO_4$) | 1.1 | 1.4 | 2.2 | 2.6 | 1.1 | 1.7 |
| Calcium sulphate ($CaSO_4$) | 9.5 | 8.5 | 6.6 | 5.8 | 9.4 | 9.2 |
| Magnesium sulphate ($MgSO_4$) | 5.5 | 5.6 | 4.6 | 6.7 | 5.4 | 4.8 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | trace | trace | trace | trace | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 11.1 | 8.1 | 5.3 | 9.9 | 4.4 | 5.7 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace | ... | ... | trace | trace | ... |
| Silica ($SiO_2$) | 14.9 | 14.4 | 15.4 | 14.9 | 13.7 | 12.9 |
| Total solids | 51.0 | 45.6 | 45.6 | 47.8 | 40.9 | 41.9 |

These waters are very slightly mineralized, and all are quite similar in their predominating chemical constituents. They may all be classed as ferruginous, bicarbonated, sulphated alkaline-saline waters, possessing slight diuretic and tonic properties. The waters have some local reputation in the inflammatory conditions of the bladder and in irritations of the genito-urinary tract.

### Sparkling Catawba Springs.

(*Catawba County.*)

*Postoffice,* Sparkling Catawba Springs. *Location,* in the western portion of the state, near the western edge of the famed Piedmont section of the state; west of Salisbury, 60 miles. *Situation,* within the shadows of the Blue Ridge Mountains, 1 mile from the south bank of the beautiful Catawba River, nestled away in a beautiful park of grand old trees and perennial shrubbery, really one of the beauty spots of the state, at an elevation of 1150 feet above tide water. The scenery is grand and impressive. *Access,* via Hickory, on the Southern Railway, thence 6 miles over good macadam roads to the springs. *Hotel,* there is a commodious resort hotel containing 100 rooms, besides a number of cottages furnishing additional accommodations. There are 3 springs, viz: White Sulphur, Blue Sulphur and Iron Springs, the latter's analysis is given herewith:

SPARKLING CATAWBA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). Iron Spring. |
|---|---|
| Sodium chloride ($NaCl$) | 17.50 |
| Sodium sulphate ($Na_2SO_4$) | 1.85 |
| Potassium sulphate ($K_2SO_4$) | 5.90 |
| Sodium bicarbonate ($NaHCO_3$) | 67.80 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 6.90 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 11.30 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.4 |
| Silica ($SiO_2$) | 20.50 |
| Total solids | 124.15 |

This is a lightly mineralized, sodic, calcic, bicarbonated alkaline water, possessing slight antacid and tonic properties. It should be useful in disturbances of digestion due to hyperacidity, especially in the anemic and chlorotic conditions in young girls just budding into womanhood.

### Rocky River Springs.

(*Stanley County.*)

*Postoffice,* Aquadale. *Location,* in the eastern Piedmont section of the state; east of Charlotte, 40 miles; south of Albemarle, 11 miles. *Situation,* in the southern portion of the county, to the west of the

Yadkin River, in a beautiful rolling section of country, lying between two streams, and occupying a small tableland surrounded by wooded hills and picturesque dales of much charm and natural beauty. *Access,* via Aquadale Station, on the Southern Railway, thence by motor, over a splendid macadam highway, 1 mile to the springs. *Hotel,* the hotel accommodations are adequate, a wooden structure with modern conveniences. There is a large cement swimming pool for the administration of genuine mineral-water bathing. The springs, 5 in number, are known as Arsenic Spring, Iron Spring, Sulphur Spring, Magnesia Spring and Blue Spring. The analyses below shows the mineralization of the 2 most important springs:

ROCKY RIVER SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). Arsenic Spring. | Iron Spring. |
|---|---|---|
| Sodium chloride ($NaCl$) | 7.2 | 15.16 |
| Sodium sulphate ($Na_2SO_4$) | 20.1 | 10.60 |
| Potassium sulphate ($K_2SO_4$) | 1.7 | 1.10 |
| Calcium sulphate ($CaSO_4$) | 9.2 | 12.00 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 27.7 | 16.40 |
| Calcium bicarbonate ($Ca_3[HCO_3]_2$) | 106.9 | 101.10 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 6.5 | 6.20 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 4.2 | 3.90 |
| Silica ($SiO_2$) | 38.9 | 36.40 |
| Total solids | 218.4 | 203.30 |
| Flow in gallons per day | 1080 | 2880 |

The so-called Arsenic Spring is a lightly mineralized, calcic, magnesic, bicarbonated alkaline-saline water.

Iron Spring is a lightly mineralized, calcic, magnesic, bicarbonated, alkaline-saline water.

A comparison of the analysis of the two springs shows that the predominating chemical constituents of the two waters are very similar in percentage content. In fact, the Arsenic Spring contains a greater percentage of iron than the Iron Spring. Both waters possess diuretic antacid and tonic properties. They should be of value in gastric disturbances due to hyperacidity and in irritable conditions of the genito-urinary tract. The waters have some local reputation and endorsement by the profession. The water from the arsenic spring is used throughout the hotel for culinary and drinking purposes. The so-called "sulphur spring" has no odor of hydrogen sulphide.

## Rivermont Springs.

(*Durham County.*)

*Postoffice,* West Durham. *Location,* in the eastern Piedmont section of the state; west of Raleigh, the capital city, 20 miles; east of Greens-

boro, 40 miles; west of West Durham, 5 miles. *Situation*, in a beautiful rolling section of country, surrounded by wooded hills and shady dells. *Access*, via West Durham Station, on the Southern Railway, thence over a splendid macadam highway, through a beautiful fertile farming country to the springs. *Hotel*, no accommodations for guests. There is a modern bottling plant for the sanitary handling of bottled waters. The water issues forth from the earth's crust, through faults in igneous rocks far below a sandstone and clay stratum. An analysis of the waters shows the following mineralization:

RIVERMONT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. N. Wilson). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | none |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 4.2 |
| Sodium chloride (NaCl) | 6.3 |
| Sodium sulphate ($Na_2SO_4$) | 4.9 |
| Calcium sulphate ($CaSO_4$) | 0.7 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | none |
| Sodium nitrate ($NaNO_3$) | none |
| Sodium nitrite ($NaNO_2$) | none |
| Sodium bicarbonate ($NaHCO_3$) | none |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 7.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 18.3 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.8 |
| Silica ($SiO_2$) | 18.3 |
| Total solids | 63.7 |
| Gases, cc. per liter, at 0° C. and 760 mm. pressure: | |
| Carbon dioxide (free) | 12.93 |
| Carbon dioxide set free from bicarbonates on evaporation | 15.63 |

A careful examination of the analysis reveals a slightly mineralized, calcic, magnesic, bicarbonated alkaline water, slightly carbon-dioxated, and possessing slight antacid, diuretic and tonic effects. The waters have some local reputation among the profession in digestive disturbances due to an excess of acidity and in disorders of the genito-urinary tract. The physicians of the city of Durham prescribe the water freely and, so far as the author can learn, with the most pleasing results.

## Vade Mecum Springs.

(*Stokes County.*)

*Postoffice*, Vade Mecum. *Location*, in the western Piedmont section of the state; west of Greensboro, 45 miles; east of Wilkesboro, 62 miles. *Situation*, at the foothills of the Blue Ridge Mountains, amid a region of great scenic beauty; Moore's Knob and Pilot Mountain, nearby, lift their peaks high into the clouds. *Access*, to Rural Hall Station, at junction of the Greensboro & Wilkesboro Division of

the Southern Railway; the Cape Fear & Yadkin Valley Division of the Southern Railway, thence by motor 16 miles to the spring, over a splendid graded macadam highway, and through a wonderfully picturesque section, where every turn in the road offers a picture pleasing to the eye, charming and delightful. *Hotels*, there are ample accommodations for 300 guests, with modern conveniences for comfort and recreation. The analysis given below shows a very high mineralization:

VADE MECUM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. F. P. Venable). |
|---|---|
| Sodium chloride ($NaCl$) | 11.09 |
| Potassium sulphate ($K_2SO_4$) | 15.00 |
| Sodium sulphate ($Na_2SO_4$) | 177.40 |
| Calcium sulphate ($CaSO_4$) | 1512.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 219.80 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 97.75 |
| Silica ($SiO_2$) | 13.20 |
| Total solids | 2046.15 |

Medicinal classification, weak calcic sulphated 4 or (−CaS4). This is a moderately highly mineralized, calcic, sodic, potassic, sulphated alkaline-saline water, carbon-dioxated, possessing diuretic and slight laxative properties, and has been used with success in disturbances of digestion and sluggishness of bowel action. The waters are bottled and shipped extensively all over the adjoining section of the state and even beyond the borders of the state.

## Vitalizer Mineral Spring.

(*Swain County.*)

*Postoffice*, Noland (R.F.D.). *Location*, in the extreme western end of the state; west of Rutherfordton, 72 miles; west of Asheville, 69 miles; southwest of Knoxville, Tenn., 45 miles. *Situation*, in Canebreak Valley, a delightful little vale lying at the foot of East Canebreak Knob, one of the spurs of the Great Smoky Mountains. The ledge of rock from which this spring flows is situated on the west side of a steep hill, about 2000 feet above sea level, amid a scene of wild, rugged and picturesque charm. *Access*, via Epp's Station, on the Murphy Division of the Southern Railway, thence only a few hundred yards to the spring. *Hotel*, there was in former days a comfortable resort hostelry here, but at present no accommodations for guests. Although little improvements have been put on this property, the location, situation, climate and general environment are quite favorable for a site for a sanitarium or health resort, as the spring water has exceptional therapeutic properties, as will be seen from a careful examination of the analysis given below, which shows the mineralization:

VITALIZER MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, North Carolina Geol. Surv.). |
|---|---|
| Sodium chloride ($NaCl$) | 10.9 |
| Sodium sulphate ($Na_2SO_4$) | 38.1 |
| Potassium sulphate ($K_2SO_4$) | 13.8 |
| Magnesium sulphate ($MgSO_4$) | 303.1 |
| Calcium sulphate ($CaSO_4$) | 884.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 23.9 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 61.6 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 20.0 |
| Silica ($SiO_2$) | 12.0 |
| Total solids | 1367.4 |
| Gas: Carbon dioxide (free). Present. | |
| Temperature, °C. | 15.6 |
| Flow, gallons per day | 600 |

Medicinal classification, weak calcic sulphated 3 or (−CaS3). A study of the analysis shows this to be a moderately mineralized, calcic and magnesic, potassic sodic sulphated, saline water. The predominating chemical constituents comprise the sulphate ions, one-fourth of the total solids combining into magnesium sulphate, Epsom salts, which give this spring aperient properties. This water has been used and endorsed by the profession as an adjuvant in the treatment of constipation, and conditions of the intestinal tract, where cathartic or purgative action is indicated.

The following springs were once used as resorts:

*Lemon Springs, P. O.*, Lemon Springs, Moore County. The location is in the eastern part of the state, about 500 feet above sea level. The hotel was destroyed by fire a great many years ago, and the resort has been allowed to pass into innocuous desuetude from undue neglect. No definite information nor satisfactory analysis available.

*Park's Springs, P. O.*, Pelham, Caswell County. These springs have been resorted to only by residents in the immediate locality. The waters are said to resemble the well-known Hunyadi-Janos water of Hungary. No definite information nor satisfactory analysis available.

*Shaw's Healing Springs, P. O.*, Littleton, Warren County. The location is only 1½ miles from the town. While once popular as a resort, no definite information nor satisfactory analysis available.

*Shocco Springs, P. O.*, Henderson, Warren County. Once a popular resort, but no definite information nor satisfactory analysis available.

*Stonewall Springs, P. O.*, Haw River, Alamance County. There are 2 springs here, 1 a chalybeate and 1 calcic sodic sulphated. A half century ago it was a popular resort, with hotel and cottages, but for want of advertising it was allowed to lapse into innocuous desuetude. No satisfactory analyses available.

*Yadkin Mineral Springs, P. O.*, Palmersville, Stanley County. Once a popular resort located near the Yadkin River. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Derita Mineral Spring, P. O.*, Derita, Mecklenburg County.

*Huckleberry Springs, P. O.*, West Durham, Durham County.

## NORTH DAKOTA.

North Dakota extends from 46° to 49° north latitude and from 96°20′30″ to 104° west longitude, and comprises an area of 70,795 square miles, of which 600 square miles are under water. The extreme length of the state from east to west is 360 miles and the extreme breadth is 210 miles. The eastern part of the state is perfectly level, the bed of an ancient lake, Agassiz, now traversed by the Red River; this portion of the state is about 1000 feet above sea level; in the north the elevation rises to over 2000 feet. Southwestward the prairies rise toward the grassy Plateau du Coteau du Missouri, which has an elevation of 2000 feet near the center of the state and rises gradually to 3000 feet toward the southwest. The climate of the state is dry and salubrious, healthful and invigorating. The winters are clear, crisp and sunny, as a rule, with heavy snowfalls. The summers have hot dry days and cool nights. The mean temperature for January is −16.7° C. (3° F.), and for July, 21.1° C. (70° F.), while a temperature of −40° C. (−40° F. below zero) is not rare.

North Dakota has no well-developed mineral spring localities and few individual springs. The older writers on mineral springs mention no places of resort; Crook lists only a few springs taken from the U. S. Geological Reports. The state reports 1 spring selling water in 1923.

There are a number of springs in this state, but so far as we have been able to learn through the state geologist, none of them are used as resorts. No definite information nor satisfactory analysis available of any of the springs that are worth mentioning. A few of them bottle the water for commercial purposes, but most of the springs are used for domestic purposes and for watering stock.

## OHIO.

Ohio extends from 38°25′ to 42° north latitude and from 80°28′ to 84°42′ west longitude, and comprises an area of 41,060 square miles, of which 300 square miles are under water. From east to west the state is 215 miles long, and from north to south the distance across the state is 210 miles. The surface of the state is generally an undulating plain, ranging in elevation from 430 feet to 1550 feet above sea level. The chief topographical feature of the state is the great divide, forming the watershed which extends diagonally across

the state from northeast to southwest, and divides the surface into two unequal slopes. There are no marked irregularities in the surface, except the trenches cut by the rivers, the Ohio Valley being lined with bluffs, which in some places are 600 feet high. The natural beauty of the river valleys present scenery of tranquil loveliness. The state is rich in the heritage of an ancient civilization. Numerous instances of Indian mounds memorialize the antiquity of the ancient tribes who once possessed this fair domain. Ruins of fortifications and embankments mark the central and western sections, the outlines of which are still visible where the ancient peoples lived and lost their heritage. The climate in general is pleasant and healthful, though variable, and subject to great and sudden changes of temperature. The mean annual temperature for the state in January is 3.3° C. (26° F.); for July, 23.3° C. (73° F.); the maximum may reach as high as 42.2° C. (108° F.) and the minimum −36.7° C. (−34° F. below zero).

Ohio has 80 spring localities, with a total of 106 individual springs, of which 15 have been analyzed, and at various times some 15 have been used as resorts; 20 springs reported sales of water during 1923. Calcic waters predominate, but there is considerable variety in other waters; many chalybeate and sulphuretted waters are found, as well as saline and alkaline waters. Walton lists 3 spring localities; Crook, 7; Peale, 15. The following list has been secured from personal correspondence with physicians and spring owners.

### Crystal Springs.

(*Licking County.*)

*Postoffice*, 91 Jefferson Road, Newark. *Location*, near the center of the state; east of Columbus, the capital city, 36 miles; west of Zanesville, 30 miles. *Situation*, in a rolling, undulating section of country, well drained and salubrious. *Access*, via Newark, on the Baltimore & Ohio Railway and on the Pennsylvania Railway, thence 2 miles by motor to the springs. *Hotel*, no accommodations for guests. The water is bottled and sold commercially. The analysis below shows the mineralization:

CRYSTAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. W. Foulk). |
|---|---|
| Potassium chloride (KCl) | 1.40 |
| Sodium chloride (NaCl) | 1.00 |
| Sodium sulphate ($Na_2SO_4$) | 6.50 |
| Calcium sulphate ($CaSO_4$) | 9.40 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 21.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 26.08 |
| Ferric oxide and alumina ($Fe_2O_3$ and $Al_2O_3$) | 1.50 |
| Silica ($SiO_2$) | 10.60 |
| Total solids | 77.68 |
| Flow, gallons in twenty-four hours | 4000 |

This is a slightly mineralized, calcic and magnesic, bicarbonated alkaline water, possessing very slight diuretic, antacid and tonic properties. It is a very pure, wholesome, potable water, and should be of value in digestive disturbances due to an excessive acid condition of the stomach. Its bland diuretic action is indicated where there is irritation of the bladder and kidneys.

### Fountain Park Magnetic Springs.

*(Champaign County.)*

*Postoffice,* Fountain Park. *Location,* southwest of central Ohio; west of Columbus, the capital city, 34 miles; east of Urbana, the county seat, 12 miles; northeast of Springfield, 30 miles. *Situation,* the elevation is 1200 feet above sea level. *Access,* via the Pennsylvania Railway (the Indianapolis Division), thence only five minutes' walk from Fountain Park Station. *Hotel,* the hotel is modern in equipment and has an up-to-date bathing department under the supervision of a competent physician. The springs (wells) are 5 in number, the largest flowing freely fills a 10-inch pipe with a hydrostatic pressure of 21 pounds. The analysis of this well shows the following mineralization:

FOUNTAIN PARK MAGNETIC SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. S. Wayne). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 233.24 |
| Magnesium chloride ($MgCl_2$) | 36.25 |
| Calcium chloride ($CaCl_2$) | 79.16 |
| Potassium sulphate ($K_2SO_4$) | 44.63 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 316.07 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 726.90 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.23 |
| Silica ($SiO_2$) | 10.71 |
| Total solids | 1451.25 |

Medicinal classification, weak alkaline b3 or (−Ab3). The analysis shows this to be a moderately mineralized, calcic, magnesic, bicarbonated, muriated, alkaline-saline water, possessing diuretic and antacid properties. The water is said to be valuable in the treatment of acid dyspeptic affections and in the treatment of chronic rheumatism and gout, and has secured favorable mention in bladder and kidney disorders.

### Green Springs.

*(Seneca County.)*

*Postoffice,* Green Springs. *Location,* in the northern portion of the state; southeast of Toledo, 40 miles; southwest of Cleveland, 90 miles. *Situation,* in a beautiful 45-acre park of giant oaks and other indigenous

trees. The park is intersected with graded walkways, and the beautiful green lawns are adorned with hardy perennials and other cultivated flowers. *Access*, via the Nickel Plate and Big Four Railways, thence only ½ mile by motor to the springs; via the national highways, for motorists. *Hotels*, there are 3 modern resort hostelries, open all the year. The bathing establishment is modern in construction and equipment, and conducted under the supervision of an expert in hydriatics, with a corps of trained assistants. Every form of hydrotherapeutic and balneotherapeutic treatment is administered.

For enormity in size and beauty of its surroundings, perhaps no spring in the country excels Green Springs. Through a fissure in the igneous bedrock Nature pours forth a gushing stream of water, 200,000 gallons daily, in such volume that it might well be called a river. The analysis shows the following mineralization: The temperature of the water as it emerges from the earth is 10° C. (50° F.) throughout the year, and never freezes, even a mile below the spring. The medicinal properties of this water was known to the Indians before the advent of the white man; they called the spring "medicine water." It is said that the old Seneca chief, "Hickory," made many lamentations when the time came for him to leave this "medicine water."

GREEN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 324.90 |
| Sodium chloride (NaCl) | 277.00 |
| Calcium sulphate ($CaSO_4$) | 678.22 |
| Magnesium sulphate ($MgSO_4$) | 377.69 |
| Ferrous sulphate ($FeSO_4$) | 51.30 |
| Potassium hydrobromate ($KHBrO_3$) | 72.17 |
| Sodium bicarbonate ($NaHCO_3$) | 290.80 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 798.77 |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silica ($SiO_2$) | 78.54 |
| Organic matter | 44.81 |
| Total solids | 1986.18 |

Medicinal classification, weak alkaline b3, weak saline2, weak sulphate 3, very weak ferruginous or (−Ab3, −Cl2, −S3, − −Fe). The analysis shows a moderately highly mineralized, magnesic, sodic bicarbonated and magnesic, calcic sulphated alkaline-saline water, carbondioxated and sulphuretted, possessing diuretic, laxative, tonic and alterative properties. The water is highly endorsed by the profession in disorders of the gastro-intestinal tract, in irritable conditions of the genito-urinary tract, in diseases of the liver and biliary ducts, rheumatism and the uric-acid diathesis. Pleasing results have been obtained from its use in diseases peculiar to women. The liberal content of iron in this water makes it a valuable tonic in run-down, depleted conditions, in anemia and chlorosis and in all depraved conditions of the blood and blood-making organs.

## Magnetic Springs.

*(Union County.)*

*Postoffice,* Magnetic Springs. *Location,* in central Ohio; south of Toledo, 60 miles; northeast of Cincinnati, 110 miles; northwest of Columbus, the capital city, 36 miles. *Situation,* in a well-wooded, rolling region of healthful hills and dales, with an elevation of about 600 feet above sea level. *Access,* via Delaware Station, on the Erie Railway, thence by motor 12 miles to the springs; via Richwood Station, on the Hocking Valley Railway, Big Four and Pennsylvania Railways. *Hotel,* the hotel has recently been remodeled and refurnished. The bathing establishment, modern in construction and equipment, is a model of the balneotherapeutic art; here every form of bath, pack and rub are given under the direct supervision of an eminent physician, well-versed in hydriatics. Competent masseurs and masseuses for both the men's and women's departments constantly on hand to administer the famous magnetic mineral water baths. The Magnetic Mineral Spring, analysis below, no doubt issues from unaltered stratified rocks of the paleozoic age. Not a single fault, trap or volcanic rent and not a trace of igneous metamorphism appears in the rocky floor of the state. For this reason all the mineral waters of the state are cold, and most of them belong to the calcic and chalybeate class.

MAGNETIC SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, unknown). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 17.60 |
| Sodium sulphate ($Na_2SO_4$) | 146.10 |
| Magnesium sulphate ($MgSO_4$) | 93.50 |
| Calcium sulphate ($CaSO_4$) | 340.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 228.09 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 308.61 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 9.20 |
| Silica ($SOi_2$) | 1.50 |
| Total solids | 1143.60 |

Medicinal classification, weak alkaline b, weak sulphate or (−Ab, −S). This is a moderately highly mineralized, calcic, magnesic, bicarbonated and sulphated alkaline-saline water, possessing diuretic, antacid, tonic and slight laxative properties. The administration of this water imparts tone to the mucous linings of the gastro-intestinal tract and to the mucous surfaces of the genito-urinary tract. The waters have been used with success in the treatment of various catarrhal conditions of the stomach and intestines, especially in chronic diarrhea and chronic colitis; in nervous affections, where a tonic is needed, this water exerts a pleasing effect. The "drinking cure" combined with the "bathing cure" in certain types of rheumatic disorders has a happy effect in relieving distressing conditions of this disease.

## Norfolk Mineral Springs.

(*Adams County.*)

*Postoffice,* Mineral Springs. *Location,* in southern Ohio; south of Columbus, the capital city, 70 miles; east of Cincinnati, 80 miles; north of Vanceburg, Ky., 30 miles. *Situation,* at the base of a high hill, at an altitude of about 500 feet above sea level. *Access,* via Peebles Station, on the Norfolk & Western Railway, thence by motor over graded mountain roads, through an interesting section of country 4 miles to the springs. *Hotel,* there is a typical resort hostelry, with conveniences and new furnishings. The table is supplied with the choicest foods, well cooked and served. The entertainment is homelike. The waters, on analysis, show the following mineralization:

NORFOLK MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. T. Marsh) |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 15.00 |
| Sodium sulphate ($Na_2SO_4$) | 50.00 |
| Magnesium sulphate ($MgSO_4$) | 85.00 |
| Calcium sulphate ($CaSO_4$) | 90.00 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 6.48 |
| Aluminum oxide ($Al_2O_3$) | 9.00 |
| Silica ($SiO_2$) | 8.00 |
| Total solids | 263.48 |

The analysis shows this to be a lightly mineralized, calcic, magnesic, sodic sulphated, saline water, possessing diuretic and light laxative properties. This water is recommended in the treatment of digestive disturbances, hepatic congestion, chronic constipation, rheumatism, gout, bladder and kidney disorders.

## Oak Ridge Mineral Springs.

(*Seneca County.*)

*Postoffice,* Green Springs. *Location,* in northern Ohio; east of Toledo, 30 miles; north of Cincinnati, 175 miles; south of Sandusky, 22 miles; west of Cleveland, 70 miles. *Situation,* in a beautifully picturesque region, at an altitude of about 600 feet above sea level. *Access,* via the New York, Chicago & St. Louis Railway and the Sandusky Division of the Big Four Railway. *Hotel,* there is a resort hostelry, with fair conveniences. The Oak Ridge Mineral Spring (well) is in reality an artesian well, 127 feet in depth, with a large flow of water; the analysis shows the mineralization:

OAK RIDGE MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. W. Foulke). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 4.95 |
| Sodium chloride (NaCl) | 29.58 |
| Magnesium sulphate ($MgSO_4$) | 339.09 |
| Calcium sulphate ($CaSO_4$) | 1552.16 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 827.78 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.68 |
| Silica ($SiO_2$) | 10.94 |
| Total solids | 2767.18 |

Gases:
Hydrogen sulphide present.

Medicinal classification, weak alkaline b2, calcic sulphate or (−Ab2, CaS), sulphuretted. This is a moderately highly mineralized, calcic, magnesic sulphated and bicarbonated alkaline water, sulphuretted, possessing diuretic and slight laxative properties, and used with success in the treatment of chronic rheumatism, bladder and kidney disorders, renal and vesical calculi, congestion of the liver and gall ducts, neurasthenia and general debility.

## Spring Valley Springs.

*(Greene County.)*

*Postoffice,* Spring Valley. *Location,* in southwestern Ohio; southwest of Columbus, the capital city, 65 miles; south of Springfield, 25 miles; northeast of Cincinnati, 45 miles. *Situation,* in the valley of the Little Miami River, at an elevation of about 600 feet above sea level. *Access,* via the Spring Valley Station, on the Pennsylvania Railway lines and connections. *Hotel,* no definite information as to class of accommodations, but good hotel in the town. The analysis below shows the mineralization:

SPRING VALLEY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. C. S. Adams). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 2.91 |
| Potassium chloride (KCl) | 644.50 |
| Sodium chloride (NaCl) | 15,399.00 |
| Magnesium chloride ($MgCl_2$) | 192.80 |
| Potassium bromide (KBr) | 39.90 |
| Iodine (I) | trace |
| Magnesium sulphate ($MgSO_4$) | 636.70 |
| Calcium sulphate ($CaSO_4$) | 3,988.00 |
| Ferrous sulphate ($FeSO_4$) | 6.80 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 1,121.00 |
| Sodium nitrate ($NaNO_3$) | 0.41 |
| Sodium nitrite ($NaNO_2$) | 0.15 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 15.50 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 156.60 |
| Aluminum oxide ($Al_2O_3$) | 83.00 |
| Silica ($SiO_2$) | 15.00 |
| Total solids | 22,100.00 |

Medicinal classification, weak acid aluminic sulphated 4, strong saline 1.6, calcic sulphated 2 or (−AcAl S4, +Cl 1.6, CaS2). This is a highly mineralized, sodic, muriated, potassic, calcic and aluminic sulphated acid (bromic) water, possessing diuretic, laxative, tonic, alterative and reconstructive properties. The sulphate ions in solution in this water are sufficient to exert a stimulating effect upon the intestinal musculature and upon the hepatic function. The sulphate salts liquefy the intestinal mucus and bowel contents and aid in the excretion of intestinal waste. Its diuretic action makes it a valuable water in affections of the genito-urinary tract. Its tonic properties, potassum, bromide, iron and aluminum give it tonic and reconstruction properties.

## Stryker Mineral Springs.

(*Williams County.*)

*Postoffice,* Stryker. *Location,* in northwestern Ohio; west of Toledo, 60 miles; north of Cincinnati, 170 miles; east of South Bend, Ind., 100 miles. *Situation,* in the village of Stryker, which is surrounded by a fertile agricultural region of rolling hills, undulating savannas, at an elevation of about 490 feet above sea level. *Access,* via the Air Line Division of the Lake Shore & Michigan Southern Railway. *Hotel,* formerly visitors were received in private families, but a new hotel is now under construction which will be fitted and equipped with all modern conveniences, including hospital facilities and a bathing establishment, modern in construction and equipment. The analysis below shows the mineralization:

STRYKER MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. A. Kirchmaier). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 11.20 |
| Sodium chloride (NaCl) | 11,190.70 |
| Magnesium chloride ($MgCl_2$) | 1,357.20 |
| Calcium chloride ($CaCl_2$) | 1,029.60 |
| Calcium sulphate ($CaSO_4$) | 253.10 |
| Strontium sulphate ($SrSO_4$) | 73.30 |
| Sodium phosphate ($Na_2HPO_4$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 115.18 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1,015.41 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 82.62 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 125.90 |
| Silica ($SiO_2$) | 21.20 |
| Total solids | 15,274.41 |

Gases: Hydrogen sulphide (free), undetermined.

Medicinal classification, weak alkaline b3, strong saline 1.5 or (−Ab3, +Cl 1.5), sulphuretted. The analysis shows this to be a

highly mineralized, sodic, calcic, magnesic muriated and bicarbonated saline (ferruginous) water, sulphuretted, possessing diuretic, antacid, aperient and tonic properties. The sulphate ions are not present in sufficient amounts to actively stimulate intestinal secretion, but with the magnesium chloride and the large amount of sodium chloride gives laxative and cathartic properties. The water is also rich in iron and therefore is a valuable tonic water indicated in anemia, chlorosis and general debility.

### Yellow Springs.

(*Greene County.*)

*Postoffice*, Yellow Springs. *Location*, in southwestern Ohio; northeast of Cincinnati, 74 miles; southeast of Columbus, the capital city, 55 miles. *Situation*, near the banks of the Little Miami River, at an altitude of about 600 feet above sea level. Yellow Springs is situated at the top of a high gorge between precipitous cliffs. *Access*, Yellow Springs Station, on the Little Miami Railroad and New York Central Railway System and connections. *Hotel*, in the olden days there was a 300-room hotel, which was destroyed by fire in 1892. There are hotel accommodations at Yellow Springs, but information as to class of accommodations at the spring is meagre. This spring is one of a large number of travertine springs located in this area, being the largest in the locality. This spring is charged with calcium magnesium and iron bicarbonate, which tends to deposit the carbonates as the carbonic-acid escapes. This deposit is termed travertine. Antioch College is the owner of the springs, and Prof. C. S. Adams, of the Department of Chemistry of this institution, has studied this deposit. Data taken in 1828 and in 1925 indicate that the spring has a constant regular flow of 156,960 gallons every twenty-four hours. Knowing the amount of travertine deposited in the large mound outside the spring, and the amount of iron, calcium and magnesium carbonates deposited daily, Prof. Adams has estimated the age of the spring to be thirty thousand years. This travertine deposit contains the vegetation of the past thirty thousand years, preserved sufficiently for study, and has offered a fertile field for investigation of the vegetation of the vicinity since the last glacial period. The travertine deposit is orange-yellow, hence the name Yellow Springs. The location of the spring is unusual in that it emerges from a portion of the gorge much higher than the surrounding country, which fact, together with the temperature of the water and the large flow which is not affected either by drought or flood, has given rise to the theory that it comes from great depths. The analysis shows the following mineralization:

YELLOW SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. B. Dole). |
|---|---|
| Potassium chloride (KCl) | 3.62 |
| Sodium chloride (NaCl) | 0.66 |
| Sodium sulphate ($Na_2SO_4$) | 14.15 |
| Magnesium sulphate ($MgSO_4$) | 7.58 |
| Sodium nitrate ($NaNO_3$) | 0.14 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 213.50 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 302.80 |
| Manganese dioxide ($MnO_2$) | trace |
| Ferric oxide ($Fe_2O_3$) | 0.43 |
| Aluminum oxide ($Al_2O_3$) | trace |
| Calcium silicate ($CaSiO_3$) | 35.50 |
| Silica ($SiO_2$) | 2.70 |
| Suspended matter | 2.80 |
| Total solids | 583.88 |

Medicinal classification, weak alkaline b or (−Ab). The analysis shows this to be a moderately mineralized, calcic, magnesic, bicarbonated, alkaline water, carbon-dioxated, possessing antacid, diuretic, properties. It will be observed that more than 90 per cent of the total solids are in the form of the bicarbonates of calcium and magnesium. This water is useful in all conditions where there is acidity present, in the stomach or the genito-urinary tract. This is a pleasing potable water.

The following springs were once used as resorts:

*Adams County Mineral Springs, P. O.*, Mineral Springs, Adams County. These springs were once popular and resorted to for the relief of the stomach, bowels and liver. No satisfactory analysis available.

*Cedar Springs, P. O.*, New Paris, Preble County. There are said to be 100 springs within an area of 2 square miles, some of which are said to be used for medicinal purposes. It is claimed that some of the waters resemble those of the Bethseda Spring, at Waukesha, Wis. No definite information nor satisfactory analysis available.

*Crum Mineral Springs, P. O.*, Girard, Mahoning County. Location, within 4 miles for Youngstown. The surroundings are said to be very attractive. There are 4 springs in the area. No definite information nor satisfactory analysis available.

*Erkenbrecker's Salt Well, P. O.*, Ludlow Grove, Hamilton County. Location, 6 miles east of Cincinnati. This is said to be a very strong brine water, used principally for bathing purposes. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Alba Spring, P. O.*, West Park, Cuyahoga County.

*Beech Rock Springs, P. O.*, Zanesville, Muskingum County.

*Cartwright Farm Spring, P. O.*, Parma, Cuyahoga County.

*Collingwood Springs, P. O.*, Toledo, Lucas County.

*Devonia Mineral Spring, P. O.*, Lorain, Lorain County.
*Elm Meade Farm Spring, P. O.*, Youngstown, Trumbull County.
*Fisher's Magnesia Mineral Spring, P. O.*, Columbus, Franklin County.
*Gibson Spring, P. O.*, Youngstown, Mahoning County.
*Glenwood Spring, P. O.*, Chillicothe, Ross County.
*La France Spring, P. O.*, Toledo, Lucas County.
*Minnehaha Spring, P. O.*, West Park, Cuyahoga County.
*Pine Tree Spring, P. O.*, Willoughby, Lake County.
*Pure Spring, P. O.*, Akron, Summit County.
*Purity Spring, P. O.*, South Euclid, Cuyahoga County.
*Sand Rock Mineral Spring, P. O.*, Canton, Stark County.
*Sulphur Lick Spring, P. O.*, Chillicothe, Ross County.
*Tallewanda Mineral Springs, P. O.*, College Corner, Preble County.
*Wheeler Springs, P. O.*, Youngstown, Mahoning County.

## OKLAHOMA.

Oklahoma extends from 30° to 37° north latitude and from 96° to 103° west longitude, and comprises an area of 39,030 square miles, of which 200 square miles are covered with water. From north to south the distance across the state is 205 miles, and from east to west, including the long narrow western projection, the distance is 383 miles, while further south the distance is only 190 miles. The surface of Oklahoma generally is a rolling plain, rising gradually from an elevation of about 800 feet in the extreme east to 2500 feet on the western boundary of the main portion and to 5000 feet in the western boundary of Beaver County. The climate of Oklahoma is equable and generally salubrious; there is, nevertheless, a considerable range of temperature, and the region is subject to sudden severe cold waves. The maximum temperature recorded during a period of eight years was 45.13° C. (115° F.) and a minimum of −31.8° C. (25° F. below zero).

Oklahoma has few spring localities, and the few that exist are little known and of slight importance. The character of the waters are sulphuretted, saline and chalybeate. Although a few localities are mentioned as resorts, they were, as a rule, unimproved until recently; there are now two areas of some prominence as resorts—the Platt National Park and the Hercules Sanatorium. Seven spring localities reported sales of water during the year 1923.

### Artesian Hotel Well.

(*Murray County.*)

*Postoffice,* Sulphur. *Location,* in the middle southern portion of Oklahoma; south of Oklahoma City, 100 miles; south of Guthrie, 130 miles. *Situation,* at the base of Arbuckle Mountain, at an elevation of 1000 feet above sea level, in the midst of a rough

and rugged picturesque country. *Access,* via the San Francisco & Santa Fe Railway Systems, with branch line to Sulphur, and via motor over the great national highways, which reach the park from all points. *Hotel,* there is a modern hostelry, with conveniences. The hotel has a large natatorium and dancing pavilion—a mecca for devotees of this form of out-door entertainment. The climatic conditions are pleasing, cool in summer and the winters are generally mild. The analysis shows the following mineralization for the water:

ARTESIAN HOTEL WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. E. Johnson). |
|---|---|
| Sodium chloride (NaCl) | 603.62 |
| Magnesium sulphate ($MgSO_4$) | 64.79 |
| Calcium sulphate ($CaSO_4$) | 6.84 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 88.81 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 295.82 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.22 |
| Silica ($SiO_2$) | 20.70 |
| Total solids | 1082.81 |
| Gases: | |
| Free carbon dioxide | 240.00 |
| Flow in gallons per day | 8000 |

Medicinal classification, weak alkaline b, weak saline 2 or (−Ab, −Cl 2). This is a moderately mineralized, sodic muriated and calcic bicarbonated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid and slight tonic properties. The analysis shows that 60 per cent of the chemical constituents are in the shape of the chloride of sodium and 30 per cent as calcium bicarbonate. This water should have a very pleasing effect upon gastric disturbances due to acidity, accompanied by pyrosis and water brash. In distressing conditions of the alimentary canal with sluggish bowel movement this water, on account of the sulphate radicles present and the sodium chloride, stimulate intestinal activity and hepatic function.

## Hercules Springs.

(*Logan County.*)

*Postoffice,* Guthrie. *Location,* near the center of the state; north of Oklahoma City, 30 miles; slightly northwest from Fort Smith, Ark., 180 miles. *Situation,* in a rolling prairie region, drained by the Cimarron River. The springs (wells) are situated in Guthrie. *Access,* via the Santa Fe Railway System and via the Fort Mills & Western Electric Interurban Railway, and also by motor, over the great national highways which intersect this section. *Hotel,* there is a large commodious hostelry, with modern conveniences, open throughout the year. The bathing establishment, a part of the institution, is modern in construction and equipment. The hydrothera-

peutic department is equipped for every form of physiotherapeutic treatment. The springs (wells), 4 in number, of which we present the analyses of the 3 more important:

HERCULES SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). Hercules Spring. | Sooner Spring. | Bromide Spring. |
|---|---|---|---|
| Ammonium chloride ($NH_4Cl$) | 6.149 | | |
| Lithium chloride (LiCl) | trace | | |
| Potassium bromide (KBr) | ... | ... | 95.760 |
| Potassium chloride (KCl) | trace | | |
| Sodium chloride (NaCl) | 18,482.004 | 461.358 | 3226.086 |
| Sodium bromide (NaBr) | 14.678 | | |
| Potassium iodide (KI) | ... | ... | 44.460 |
| Sodium iodide (NaI) | 1.785 | | |
| Sodium sulphate ($Na_2SO_4$) | 615.411 | 124.488 | 1117.086 |
| Magnesium sulphate ($MgSO_4$) | 1,661.463 | | |
| Calcium sulphate ($CaSO_4$) | 2,375.856 | 356.535 | 290.871 |
| Sodium nitrate ($NaNO_3$) | 60.202 | | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 403.279 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 152.737 | 35.371 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 20.776 | |
| Potassium bicarbonate ($K[HCO_3]_2$) | ... | ... | 228.264 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 3.601 | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 4.066 | | |
| Silica ($SiO_2$) | 16.275 | 7.001 | |
| Total solids | 23,390.626 | 1009.130 | 5405.806 |

Hercules Spring, medicinal classification, strong saline 2, calcic sulphated 2 (iodic) or (+Cl 2, CaS2(I)). This is a highly mineralized, sodic, muriated saline (bromic, iodic) water, carbon-dioxated, possessing diuretic, tonic, laxative and alterative properties.

Sooner Spring, medicinal classification, weak saline, weak calcic sulphated or (−Cl, −CaS). This is a moderately mineralized, sodic, muriated and calcic sulphated, saline water, carbon-dioxated, possessing antacid and diuretic properties.

Bromide Spring, medicinal classification, weak alkaline, saline 1.6, weak sulphated 4 (iodic) or (−Ab, Cl 1.5, −S4(I)). This is a moderately mineralized, sodic muriated and sodic and potassic, bicarbonated, alkaline-saline (bromic, iodic) water, carbon-dioxated, possessing diuretic, antacid and sedative properties.

These waters are highly endorsed by the profession in a wide range of diseased conditions. The Hercules water has been found useful in the treatment of rheumatism and arthritic joint disturbances, in gastro-intestinal disorders, acidosis, gastritis, colitis and autointoxication and in catarrhal disturbances of the gall-bladder and ducts. Sooner Spring water has given relief in acid dyspepsia and disorders due to acidity of the stomach. The Bromide Spring has been recommended as very beneficial in the treatment of nervous disturbances, hysteria, neurasthenia, neuritis and sciatica, etc. The latter is one of the most highly mineralized bromide waters in the country.

## Kalium-Faxton Mineral Wells.

*Postoffice,* P. O. Box 833, Lawton. *Location,* in southwestern Oklahoma; southwest of Guthrie, 120 miles; southwest of Oklahoma City, 102 miles; northwest of Fort Worth, Tex., 140 miles. *Situation,* in the town of Faxton, amid a rolling prairie region, well drained, healthful and salubrious. *Access,* via Chicago, Rock Island & Pacific Railway, a connection of the Missouri, Pacific Railway System, thence a distance of 22 miles by motor to Faxton, where the wells are situated. *Hotel,* no accommodations for guests. The waters are bottled and shipped. The analysis below shows the mineralization:

KALIUM-FAXTON MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. E. DeBarr). |
|---|---|
| Magnesium chloride ($MgCl_2$) | 1,558.50 |
| Sodium chloride (NaCl) | 4,522.00 |
| Potassium bromide (KBr) | 22.00 |
| Potassium iodide (KI) | 16.00 |
| Sodium sulphate ($Na_2SO_4$) | 4,356.00 |
| Calcium sulphate ($CaSO_4$) | 1,955.00 |
| Potassium nitrate ($KNO_3$) | 21.00 |
| Potassium bicarbonate ($K[HCO_3]_2$) | 1,146.96 |
| Sodium bicarbonate ($NaHCO_3$) | 466.56 |
| Ferric oxide ($Fe_2O_3$) | 20.00 |
| Total solids | 14,068.02 |

Medicinal classification, weak alkaline b4, saline 3, sulphate 3 (iodic) or (−Ab4, Cl 3, S3(I)). This is a highly mineralized, sodic and calcic, sulphated and muriated saline (bromic, iodic) water, nitrated, possessing diuretic, antacid, laxative, tonic and alterative properties. This water is of value in the treatment of gastro-intestinal disorders, chronic gastritis, hyperchlorhydria, intestinal toxemia and constipation. It is also useful in the treatment of hepatic disorders, catarrh of the gall ducts, renal and vesical disorders, nutritional disorders, where an alterative tonic is indicated, syphilis, etc. It is a very strong water and should be administered in the proper dosage.

## Platt National Park Sulphur Springs.

*(Murray County.)*

*Postoffice,* Sulphur. *Location,* in the middle southern portion of the state; north of Sherman, Tex., 65 miles; south of Oklahoma City, 100 miles. *Situation,* at the base of Arbuckle Mountain, 1000 feet above sea level, in the midst of a rugged, picturesque country. *Access,* via San Francisco & Santa Fe Railway Systems, with branch lines to Sulphur, and via motor, over the great national highways, which reach the park from all important points. *Hotels,* there are modern, equipped hostelries, offering every comfort and convenience for the

pleasure and entertainment of guests. The Eleazer Bath-house is a fully equipped institution for the administration of all known baths, under the professional direction of an expert in hydrotherapy and balneotherapy. There are in addition, the Vendome and Artesian Natatoriums, both fully equipped with all modern conveniences, besides numerous free swimming pools. Platt National Park contains 32 mineral springs, no two alike in chemical constituents; the principal 2 are shown in the analyses given below:

PLATT NATIONAL PARK SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. T. Allen). Medicine Spring. | Sodium chloride Spring. |
|---|---|---|
| Potassium chloride (KCl) | 23.38 | 21.3 |
| Potassium bromide (KBr) | 0.30 | 8.6 |
| Potassium iodide (KI) | 0.18 | |
| Sodium sulphohydrate (NaHS) | 8.75 | |
| Sodium chloride (NaCl) | 3958.10 | 3224.6 |
| Sodium sulphate ($Na_4SO_4$) | 21.63 | |
| Sodium sulphide ($Na_2S$) | ... | 255.2 |
| Sodium bicarbonate ($NaHCO_3$) | 364.99 | 291.3 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 188.94 | 146.8 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 199.43 | 259.7 |
| Silica ($SiO_2$) | 16.80 | 105.0 |
| Ferric sulphide (FeS) | 1.90 | |
| Total solids | 4782.51 | 4217.5 |
| Gases, at 0° C. and 760 mm. pressure: | | |
| Hydrogen sulphide, cc. per liter | 4.8 | |

Medicine Spring, medicinal classification, weak alkaline ab2, saline 2 or (−Ab2, Cl 2), sulphuretted. This is a moderately highly mineralized, sodic, muriated, alkaline saline (bromic, iodic) water, sulphuretted.

Sodium Chloride Spring, medicinal classification, weak alkaline ab2, saline 1.6 or (−Aab2, Cl 1.6), sulphuretted. This is a moderately highly mineralized, sodic muriated alkaline-saline (bromic) water, sulphuretted.

The predominating chemical constituent in both the above waters is sodium chloride; when going into solution it dissociates into its ions sodium and chlorine, the latter being one of the most effective antiseptics and one which counteracts disease germs. Among the other ingredients are sulphur, iron, soda and magnesia. The physiological action of these waters improves the appetite, induces sleep, soothes tired nerves. The waters have been used and are highly endorsed by the profession in rheumatic and arthritic diseases, disorders of the gastro-intestinal tract and in diseases of the kidney and liver. Many permanent cures are recorded from using these waters as hot baths in various rheumatic affections and skin troubles

Platt National Park, one of the nation's greatest health and recrea-

tion resorts, the ancient outing place of the red man, has been beautified under the Federal Government's supervision, and dedicated forever for the pleasure of the people. The area of the park embraces 848 acres of Nature's most beautiful handiwork, enhanced with every tree, flower and shrub that flourishes in the great southwest. The park contains 15 miles of picturesque, scenic driveways, through valleys and over the hills hundreds of feet above the silvery Travertine Creek, with its numerous waterfalls and placid lakes, presenting a sylvian scene of great charm.

## Radium Water Wells.

(*Rogers County.*)

*Postoffice*, Claremore. *Location*, in northeastern Oklahoma; east of Guthrie, 110 miles. *Situation*, in the city of Claremore, surrounded by a rolling prairie region of fertile farms. The altitude is about 1000 feet above tide water, healthful and salubrious. *Access*, the Frisco and St. Louis Railway, Iron Mountain Railway and Southern Railway. Ten Frisco trains stop at Claremore daily. *Hotel*, there are a number of good hotels. The bathing establishment is modern in construction and equipment. Every known method of hydrotherapy and balneotherapy is practised here under the direct supervision of an expert hydrologist. The baths are given at various temperatures, running from 15.5° to 43.3° C., followed by packs, sweats, massage, alcohol rubs, etc. The water is highly charged with hydrogen sulphide. The analysis below shows the mineralization of 1 of the 6 wells, all very similar:

RADIUM WATER WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. H. Keiser). |
|---|---|
| Lithium chloride (LiCl) | 5.54 |
| Sodium chloride (NaCl) | 32,934.17 |
| Magnesium chloride ($MgCl_2$) | 1,818.44 |
| Calcium chloride ($CaCl_2$) | 1,184.55 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 39.53 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 547.80 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 131.33 |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silica ($SiO_2$) | trace |
| Total solids | 36,561.36 |

Medicinal classification, strong saline 3.5 or (+Cl 3.5). This is a very highly mineralized, sodic magnesic, calcic muriated, saline (ferruginous) water, sulphuretted, possessing diuretic, laxative and tonic properties. These waters are said to be very highly radio-active and to possess therapeutic properties of value in the treatment of chronic skin diseases, rheumatism, rheumatic arthritis and all chronic joint disturbances; sulphur waters, carrying as much as 20 cc. of sulphuretted

hydrogen to the liter, are useful in the treatment of the liver, spleen, skin diseases, etc.

The following springs reported the sale of water in 1924:
*Everpure Well, P. O.*, Oklahoma City, Oklahoma County.
*Excelsior Well, P. O.*, Oklahoma City, Oklahoma County.
*Kaiser Well, P. O.*, Oklahoma City, Oklahoma County.
*Sparkling Water Well, P. O.*, Shawnee, Pottawatomie County.
*Standard Wells, P. O.*, Tulsa, Tulsa County.
*White Sulphur Springs, P. O.*, Sapulpa, Creek County.
*Work's Excelsior Mineral Wells, P. O.*, Comanche, Stephens County.

## OREGON.

Oregon extends from 42° to 46°18′ north latitude and from 116°40′ to 124°25′ west longitude, and comprises an area of 96,030 square miles, of which 1470 square miles are under water. The extreme length of the state from east to west is 396 miles and the breadth across the state from north to south is 300 miles. The state is divided by the Coast, Cascade and Blue Mountains into well-marked areas. The Cascade Mountains vary in elevation from 4000 to 11,000 feet; running from north to south, they divide the state into Eastern and Western Oregon. The highest peaks in this range are Mount Hood and Mount McLaughlin, each 11,000 feet high. There are many lakes, principally in the southern portion of the state; some of considerable size, the largest of which is Goose Lake, which lies partly in California; Klamath Lake lies at the base of the Cascades, 30 miles long; Lake Malheur, on the eastern plateau, 22 miles long. In the mountain and lake region Dame Nature has been lavish with her charms, and has wrought her fancies in varied picturesque grandeur and beauty of landscape. The climate, influenced by topographical conditions, is more apparent in few places outside of Oregon. The mean annual temperature for January is 5.7° C. (42.2° F.) and for July, 16.8° C. (62.3° F.), and extremes may lower the mercury in winter to −34.4° C. (36° F. below zero). The Japanese current tempers the climate of the Pacific Coast.

Oregon has 47 spring localities, with 72 individual springs, of which 8 have been analyzed, and at various times 16 have been used as resorts. Oregon is well supplied with mineral springs, both hot and cold. The thermic springs are numerous and are usually found with faulted strata. The so-called soda springs predominate, but carbonated waters are also frequently found and, with alkaline and sulphuretted waters, comprehend most of the varieties found in the state. From various sources, chiefly through correspondence, the present list is made up. Walton's work mentions 1 locality and Crook mentions 8. There were 3 spring localities reporting water sales during 1923.

## Belknap Hot Medical Springs.

(*Lane County.*)

*Postoffice*, Balknap Springs. *Location*, in the midwestern portion of the state; south of Portland, 125 miles; east of Eugene, the county seat, 65 miles; in the very heart of the Cascade National Forest. *Situation*, amid the Cascade Range of the Rockies, a wild, rugged, mountainous region, 2000 feet above sea level, in a primeval forest of great scenic beauty. *Access*, via the Southern Pacific Railway to Eugene, thence 65 miles by motor to the springs; via the new McKenzie Highway. *Hotel*, the hotel is commodious and well equipped for the entertainment of guests; open from April 1 to November 1. The bathing establishment has ample facilities for the administration of hydrotherapeutic treatments: 12 bath-rooms and a large number of tubs for both hot and cold mineral baths; a large pool or plunge is kept at a comfortable temperature. The analysis below gives the mineralization:

BELKNAP HOT MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. W. Shaw). |
|---|---|
| Potassium chloride (KCl) | 131.8 |
| Sodium chloride (NaCl) | 925.0 |
| Magnesium chloride ($MgCl_2$) | 49.8 |
| Calcium chloride ($CaCl_2$) | 1066.9 |
| Manganese chloride ($MnCl_2$) | trace |
| Calcium sulphate ($CaSO_4$) | 238.6 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0 3 |
| Silica ($SiO_2$) | 80.9 |
| Total solids | 2525.2 |

Gases in solution, free oxygen in large quantities.

Medicinal classification, saline or (Cl), oxygenated. This is a moderately highly mineralized, calcic sodic muriated, saline water (oxygenated), flowing at the rate of 12,500 gallons per day, at a temperature of 86.7° C. (188° F.). The water for internal use must be cooled to a drinkable temperature; physicians recommend its internal use in uric-acid disorders, neuritis, neurasthenia, kidney and bladder troubles, etc.; the hot baths for arthritic and rheumatic disturbances. Many, almost miraculous, cures are reported from the use of this water and the administration of hot baths. The springs have been operated for a great many years, but not on the scale which the waters merit, for the reason that only recently the new McKenzie Highway has been opened, and now it is only a matter of about two hours by motor from Portland to the springs. Plans are now under way for the construction of a new modern bathing establishment, with the latest equipment for the scientific application of the latest balneo-therapeutic practice. The cold-water supply for the hotel and grounds comes from a large free-stone spring high up on the mountain side,

and is piped, from where it gushes from a solid rock, by gravity, and furnishes an abundance of pure, sparkling, potable water. Out-door sports are awaiting the devotee of fishing, in the McKenzie River.

### Cascadia Mineral Springs.

*(Cascadia County.)*

*Postoffice,* Cascadia. *Location,* in the central western portion of the state; southeast of Salem, the capital city, 50 miles. *Situation,* in the Cascade Mountains, at the western foothills of the Cascade Range, in a rough, rugged, mountainous region, near the north bank of the Santiam River. *Access,* via the Southern Pacific to Brownsville Station, thence, by motor, 32 miles to the springs. *Hotel,* there is a mountain resort hostelry, with comfortable accommodations, open throughout the year for the past thirty years. The climatic advantages are attractive, never too hot and the winters are temperate and agreeable. The Cascadia Mineral Springs, more than a dozen all told, are all valuable mineral waters. The analysis of one of the springs is given below, which shows the following mineralization:

CASCADIA MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. W. Shaw) |
|---|---|
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 1139.88 |
| Sodium chloride (NaCl) | 2682.65 |
| Magnesium chloride ($MgCl_2$) | 437.08 |
| Calcium chloride ($CaCl_2$) | 444.23 |
| Potassium sulphate ($K_2SO_4$) | 1080.04 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 836.66 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 16.93 |
| Silica ($SiO_2$) | 44.64 |
| Total solids | 6682.29 |

Medicinal classification, weak alkaline b2, saline 2, weak sulphate 3 or (−Ab2, Cl 2, −S3). This is a moderately highly mineralized, sodic and potassic muriated saline water, possessing diuretic and tonic properties. It is of value in the treatment of catarrhal conditions of the gastro-intestinal tract; physicians recommend it in rheumatic conditions and in disorders of the bladder, kidneys and liver.

### Foley's Hot Springs.

*(Lane County.)*

*Postoffice,* Foley's Springs. *Location,* on the western slope of the Cascade Range of mountains, about 100 miles east of the Pacific

shore, the western boundary of the state; southwest of Salem, the capital city, 70 miles; west of Eugene, the county seat, 65 miles. *Situation*, among the western foothills of the Cascade Mountains, a wild, rocky, rugged region, 2000 feet above sea level, in a primeval forest, far away from the bustle, smoke and dust of city life. *Access*, via Southern Pacific Railway Station at Eugene, thence by motor, over the McKenzie Highway, recently graded and macadamized by state and Federal coöperation. This highway a few miles east of Eugene strikes the McKenzie River and follows its course up the mountain, through canyons and around cliffs to within a short distance of the neighborhood of the springs. The scenic splendor of this picturesque mountain region presents a scene of weird charm and grandeur with many awe-inspiring panoramas. *Hotel*, there is a western resort house, with modern conveniences, open from April until snow falls. The waters, on analysis, show the following mineralization:

FOLEY'S HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. W. Shaw). |
|---|---|
| Sodium chloride ($NaCl$) | 1200.5 |
| Potassium chloride ($KCl$) | 24.6 |
| Calcium chloride ($CaCl_2$) | 969.6 |
| Sodium phosphate ($Na_2HPO_4$) | 161.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 381.4 |
| Silicic acid ($H_2SiO_3$) | 187.4 |
| Total solids | 2925.2 |

Medicinal classification, weak alkaline b, saline or (−Ab, Cl), thermic. This is a moderately highly mineralized, sodic, calcic, muriated, saline (phosphatic) water, azotized, possessing diuretic and curative properties for rheumatism and kindred diseases, of which sodium is the active medicinal agent. The Foley Springs have enjoyed a well-deserved reputation for many years. Scores of people claim to get relief from drinking the waters.

## Sam-O Mineral Springs.

(*Baker County.*)

*Postoffice*, Baker. *Location*, in eastern Oregon; west of the Snake River, the boundary line between Oregon and Idaho, 40 miles; north of Huntington, 40 miles. *Situation*, in a pleasant valley, lying on the eastern slope of the Blue Mountains, at an elevation of about 3460 feet above sea level. *Access*, via the Oregon-Washington Railway & Navigation Co., a branch of the Union Pacific Railway System. *Hotel*, no accommodations for guests. The analysis following shows the mineralization:

SAM-O MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. E. Bradley). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.55 |
| Potassium chloride (KCl) | 9.50 |
| Sodium chloride (NaCl) | 30.50 |
| Manganese sulphate ($MnSO_4$) | 0.90 |
| Sodium bicarbonate ($NaHCO_3$) | 158.70 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 602.50 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 80.90 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 40.00 |
| Total solids | 923.55 |
| Temperature, °C. | 26.7 |
| Flow in gallons per day | 720,600 |

Medicinal classification, weak alkaline b2 or (−Ab2). This is a moderately mineralized, sodic and magnesic bicarbonated alkaline water, possessing antacid and diuretic properties. This water should be useful in the treatment of digestive disturbances due to acidity, and its solvent action suggests its use in the uric-acid diathesis and in all catarrhal conditions of the genito-urinary tract. Taken in liberal amounts in the early morning, it should exert gentle laxative action. The waters are bottled and shipped extensively; the bottling plant is modern in construction and equipment, meticulous care being taken to insure sanitary handling of this medicinal water.

## Wolfer's Mineral Springs.

(*Marion County.*)

*Postoffice*, Hubbard. *Location*, in the western part of the state; south of Portland, 31 miles; northeast of Salem, 21 miles; north of Mount Angel, 10 miles. *Situation*, on a hillside, 212 feet elevation, in the beautiful Willamette Valley, in the midst of a fruit and garden country. *Access*, via Hubbard Station, on the Southern Pacific Railway, thence $\frac{1}{4}$ mile to the springs. *Hotels*, accommodations are primitive, but comfortable for the summer months. This is a bold spring flowing about 6000 gallons per hour and with such force as to rise in the air, several feet, in the form of a spraying fountain. The following analysis shows the mineralization:

WOLFER'S MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, not given). |
|---|---|
| Sodium chloride (NaCl) | 303.35 |
| Potassium chloride (KCl) | 171.00 |
| Sodium sulphate ($Na_2SO_4$) | 9.92 |
| Sodium bicarbonate ($NaHCO_3$) | 275.31 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 72.85 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 116.62 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 35.90 |
| Manganous bicarbonate ($Mn[HCO_3]_2$) | Heavy trace |
| Silica ($SiO_2$) | 40.87 |
| Total solids | 1025.82 |

Medicinal classification, weak alkaline ab, weak saline or (−Aab, −Cl). This is a moderately mineralized, sodic, potassic muriated and sodic bicarbonated, alkaline-saline water, possessing diuretic, tonic and alterative properties. It has been used with success in rheumatism and gouty arthritis and in acid conditions of the stomach. There are beautiful grounds around the springs, and it is said to be an ideal place for establishing a resort sanitarium. The scenic views are pleasing and of great charm and beauty.

The following springs have been used for resorts:

*Boswell Springs, P. O.*, Boswell, Douglas County. Location, 163 miles south of Portland. Situation, on the Elk Creek, about 45 miles from the coast and 350 feet above sea level. There are 2 springs in the area, both charged with carbonic acid and sulphuretted hydrogen gas. No definite information nor satisfactory analysis available.

*Des Chutes Hot Springs, P. O.*, Warm Springs, Crook County. Located at the base of the cliffs in the valley of the Wam-Chuck River. This is a thermic water, alkaline-saline bicarbonated. No definite information nor satisfactory analysis available.

*Lake View Hot Springs, P. O.*, Lake View, Lake County. Location, it is 4 miles northeast of Goose Lake; one of the largest bodies of fresh water in the West, 50 miles in length, with an average breadth of 15 miles, lying at an elevation of 5000 feet above sea level. This is a thermic water, flowing at the rate of 500 gallons per hour. No definite information nor satisfactory analysis available.

*Lower Soda Springs, P. O.*, Lower Soda, Linn County. Location, on the south fork of the Santiam River, at an elevation of 1300 feet above sea level. The waters are said to have been useful in the treatment of stomach and kidney disorders. No definite information nor satisfactory analysis available.

*McCallister's Soda Springs, P. O.*, Lake Creek, Jackson County. Located in a picturesque mountain region, 5400 feet above sea level. Once a famous resort for persons afflicted with chronic malarial poisoning. No definite information nor satisfactory analysis available.

*Wilhoit's Soda Springs, P. O.*, Wilhoit, Clackamas County. Once a resort with local reputation. No definite information nor satisfactory analysis available.

The following spring reported the sale of water in 1924:

*Calapooya Springs, P. O.*, Cottage Grove, Lane County.

## PENNSYLVANIA.

Pennsylvania extends from 39°43′ to 42°15′ north latitude and from 70°40′ to 80°41′ west longitude, and comprises an area of 45,215 square miles, of which 230 square miles are covered with water. The distance from north to south across the state is 157¾ miles, and from east to west the distance is 302 miles. The surface of the state is

greatly diversified, being more or less level in the southeast, mountainous in the center and undulating in the west. The mountain ridges, spurs of the great Appalachian chain cross the state from northeast to southwest. The entire breadth of this rugged, mountainous region is about 200 miles. It forms numerous and fertile valleys, and contains the richest bituminous coal fields in the United States. The eastern ridge of the Appalachian Range is known as Blue Mountain and, further down in New Jersey, as the Kittatinny Range. It rises abruptly from the plain to a uniform height of something over 1000 feet, reaching 1500 feet above the sea level. It is broken by a few river gaps, which cut through the entire mountain belt as the Delaware River at Delaware Water Gap, which presents a picturesque awe-inspiring scene. The climate is varied; in the northern and western portions the winters are cold and severe; in the southern and middle section the climatic conditions are genial and agreeable the whole year round. The mean annual temperature ranges from 6.7° C. (44° F.) in the northern counties to 11.1° C. (52° F.) in the southeast; northwest of the mountains the temperature may fall to −32.3° C. (25.8° F. below zero).

Pennsylvania has 46 spring localities, with a total of 83 individual springs, 28 of which have been analyzed and 14 at various times used as resorts. The mineral springs of the state are numerous, and some of them of decided value for medicinal purposes. The chalybeate class of waters seem to predominate, but sulphuretted and other varieties are found. One spring is known to contain free sulphuric acid. Walton's work on mineral waters mentions 8 spring localities, Crook's work lists 18 and Peale records 16. From various published sources, from correspondence with physicians and spring owners, we present herewith the following list, which covers the active springs in use today. Spring owners report sales from 23 spring localities in 1923.

### Bedford Springs.

(*Bedford County.*)

*Postoffice*, Bedford Springs. *Location*, in western Pennsylvania; southeast of Pittsburgh, 96 miles; west of Harrisburg, the capital city, 106 miles; north of Cumberland, Md., 28 miles; west of Philadelphia, 207 miles; west of Gettysburg, 80 miles; from the historic town of Bedford, 1½ miles. *Situation*, in a beautiful valley, on the eastern slope of the Allegheny Mountains, at an elevation of 1300 feet above sea level. This delightful spot has been abundantly endowed with Nature's choicest attractions, and is at once a resting place for the overworked business man or the matron upon whom social demands have been too heavy; a restful sanitarium for the weak in body, who need the toning effects of the potent waters and bracing climate. *Access*, via the Bedford Division of the Pennsylvania Railway and via

the Baltimore & Ohio Railway, or via motor over the Lincoln Highway to Bedford, or the national highways, with cemented roads into the hotel grounds. *Hotel*, the hotel erected in 1817, a large, framed and porched resort house, is still running. This old hotel is now supplemented by a modern building of brick and concrete, fireproof, construction, with every convenience, 400 chambers, single and *en suite*, all outside rooms and each with a private bath; the equipment throughout is the most modern and the furnishing luxurious, every appointment of the best metropolitan hotel. There are 5 springs in the area, 4 of which, the analyses are given below, shows the variety of mineralization:

BEDFORD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Booth, Garret Blair). | | | |
|---|---|---|---|---|
| | Magnesia Spring. | Limestone Spring. | Sulphur Spring. | Sweet Spring. |
| Ammonium chloride ($NH_4Cl$) | 0.6 | ... | 0.11 | |
| Lithium chloride (LiCl) | trace | ... | trace | trace |
| Potassium chloride (KCl) | 3.6 | ... | 2.81 | |
| Sodium chloride (NaCl) | 4.4 | 2.93 | 4.12 | 0.8 |
| Potassium sulphate ($K_2SO_4$) | ... | 4.61 | | |
| Sodium sulphate ($Na_2SO_4$) | 13.7 | ... | 8.00 | |
| Strontium sulphate ($SrSO_4$) | ... | 1.36 | | |
| Magnesium sulphate ($MgSO_4$) | 70.3 | 4.96 | 324.20 | 3.1 |
| Calcium sulphate ($CaSO_4$) | 1650.0 | 9.93 | 456.20 | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | ... | trace | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 52.11 | ... | 0.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 267.3 | 196.52 | 544.40 | 13.3 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 1.10 | ... | 1.6 |
| Ferrous oxide ($Fe_2O_3$) | 1.4 | ... | 1.00 | |
| Aluminum oxide ($Al_2O_3$) | 1.6 | ... | 1.00 | |
| Calcium silicate ($CaSiO_3$) | 45.7 | ... | 25.20 | |
| Silica ($SiO_2$) | ... | 8.04 | 9.20 | 8.0 |
| Total solids | 2058.6 | 281.56 | 1377.14 | 27.4 |
| Gases: | | | | |
| Carbon dioxide (free), cc. per liter | 8.9 | | | |
| Carbon dioxide, evaporated to dryness | 36.7 | | | |
| Flow in gallons per day | 24,000 | | | |

Magnesia Spring, medicinal classification, weak calcic sulphated 4 or (−CaS4). This is a moderately mineralized, calcic, sulphated, bicarbonated, saline water, carbon-dioxated, possessing diuretic and tonic properties. This water is highly endorsed by the medical profession, and has been used with satisfactory results in the treatment of catarrhal disorders of the gastro-intestinal tract, constipation and autointoxication, also in catarrhal diseases of the liver, gall-bladder and ducts. This water is laxative in small doses and purgative in larger. The small lithic chloride content widens its field of usefulness, especially in disorders of the bladder and kidneys.

Limestone Spring is a moderately mineralized, calcic, bicarbonated, sulphated, alkaline water, carbon-dioxated, possessing diuretic, antacid and slight tonic properties. It should be valuable in the treatment of gastric conditions due to acidity and as a tonic in anemia and run-down conditions it will increase the coloring matter of the red blood cells.

Sulphur Spring, medicinal classification, weak alkaline b, weak calcic sulphated 2 or (−Ab, −CaS2). This is a moderately mineralized, calcic and magnesic, sulphated bicarbonated alkaline-saline water, sulphuretted, possessing diuretic, antacid and alterative properties, and a valuable water in the treatment of rheumatism, gout and catarrhal conditions of the stomach and intestinal tract. Baths in this water are helpful in the treatment of various disorders of the integumentary system.

Sweet Spring is a very slightly mineralized, calcic, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic properties; it is well borne by the most delicate stomach and exerts a happy effect upon the genito-urinary system. The low mineralization closely approaches the waters from the celebrated water from Poland Springs in Maine.

The water from the Magnesia Spring is bottled and sold under the the name of Bedford Mineral Water, and from the Sweet Spring as Bedford Table Water. The bottling establishment is modern in construction and equipment, and the most meticulous care is exercised in the sanitary handling of the bottled waters.

There are many opportunities for wholesome amusements, golf, tennis, horseback riding, swimming, hiking, etc., besides there is always comfortable companionship awaiting one indoors, cards, music, dancing, etc. A resident physician is in constant attendance to advise concerning the "Bedford cure," a rational three weeks' course of drinking the mineral waters, regulating exercise, rest, diet, bath and massage. (See also Chapter XV.)

### Cloverdale Lithia Springs.

*(Cumberland County.)*

*Postoffice*, Newville. *Location*, in the central southern section of the state. *Situation*, 2½ miles west from Newville; 5 miles south of Doubling Gap White Sulphur Springs, amid the foothills of the Blue Ridge Mountains. *Access*, via main line, C. V. Division of the Pennsylvania Railway to Newville Station, thence 3 miles to the springs. *Hotel*, no accommodations; no resort. One spring, or, more properly, a well, was discovered in 1865 by a party prospecting for oil. The well was bored through solid rock to a great depth, when this vein of water was tapped, which, being released from its subterranean chamber, gushed forth at the rate of 300 gallons per hour, under the pressure of its own carbonic-acid gas. The flow after sixty years continues

at the same rate, being uniform in all seasons. The following analysis, made by the Water Laboratory of the United States Department of Agriculture, shows the mineralization:

CLOVERDALE LITHIA SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Geol. Surv.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.3 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 1.7 |
| Potassium sulphate ($K_2SO_4$) | 0.7 |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium sulphate ($Na_2SO_4$) | 26.6 |
| Magnesium sulphate ($MgSO_4$) | 2.5 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 48.1 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 98.6 |
| Ferric oxide ($F_2O_3$) | 0.4 |
| Silica ($SiO_2$) | 15.9 |
| Total solids | 194.8 |
| Dissolved gases, cubic inches at 30 pounds' pressure and at 15.6° C. (60° F.): | |
| Carbonic acid | 1.070 |
| Oxygen | 1.109 |
| Nitrogen | 6.013 |
| Total gases | 8.910 |

This is a lightly mineralized, calcic magnesic bicarbonated alkaline water, azotized, possessing antacid, aperient and diuretic properties. It is clear and sparkling, and its freedom from organic impurities makes it a desirable table water. It is sold commercially, and is said to keep indefinitely.

## Colvin's White Sulphur Springs.

(*Bedford County.*)

*Postoffice,* Sulphur Springs. *Location,* in the southern central section of the state; west of Lancaster, 115 miles; south of Altoona, 40 miles; southeast of Pittsburgh, 85 miles. *Situation,* Among the foothills of the eastern slope of the Allegheny Mountains nestles a pine-grown plateau called Millegan's Cove; from this picturesque retreat, about 1500 feet above sea level, issues this natural white sulphur water. *Access,* via the Bedford Division of the Pennsylvania Railway, main line connections at Altoona; also via the Huntingdon & Broadtop Division at Huntingdon, affording direct communications, east, west, north and south. The distance from the station is less than 2 miles, over splendid scenic highways. *Hotel,* there is a commodious resort, modern hostelry, offering accommodations from May 1 to November 1. The bathing establishment is equipped for the scientific administration of hot and cold sulphur baths and the general administration of

balneotherapeutic treatments. The following analysis shows the mineralization:

COLVIN'S WHITE SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. F. A. Genth). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Sodium chloride (NaCl) | 3.29 |
| Sodium sulphate ($Na_2SO_4$) | 17.19 |
| Potassium sulphate ($K_2SO_4$) | 3.70 |
| Calcium sulphate ($CaSO_4$) | 6.08 |
| Magnesium sulphate ($MgSO_4$) | 16.78 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 154.63 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 22.03 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 11.29 |
| Silica ($SiO_2$) | 30.96 |
| Total solids | 274.23 |

The analysis shows a moderately mineralized, calcic, bicarbonated alkaline (ferruginous) water, sulphuretted, possessing diuretic, antacid and tonic properties. The presence of hydrogen-sulphide gas is very perceptible, and adds to the therapeutic efficiency of the water; the natural sulphur gases are highly recommended by the profession in the hot baths for the treatment of rheumatic arthritis and similar lithemic conditions. The water is also held in high esteem in the treatment of disorders of the genito-urinary tract, the gastro-intestinal tract and in diseases of the liver and gall ducts. The liberal content of the bicarbonate of iron imparts to the water valuable tonic properties in all run-down and depleted conditions of the blood and blood-making organs, where an iron tonic is indicated.

## Cresson Springs.

(*Cambria County.*)

*Postoffice*, Cresson. *Location*, a little southwest of the midcenter of the state; west of Philadelphia, 250 miles; west of Harrisburg, the capital city, 100 miles; east of Pittsburgh, 102 miles. *Situation*, on the crest of the Allegheny Mountains, 2300 feet above sea level. The scenery is beautiful, grand and impressive; the climate is dry, bracing and salubrious. *Access*, via the Pennsylvania Railway. *Hotel*, this was once a large resort hostelry. The buildings and cottages are now no more, although the springs, like Tennyson's brook, "flows on forever." There are a number of springs in the area, but the more important are shown in the analyses below, which gives the mineralization:

CRESSON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. F. A. Genth). | | | |
|---|---|---|---|---|
| | Pure Spring. | Iron Spring. | Alum Spring. | Magnesia Spring. |
| Sodium chloride ($NaCl$) | 2.76 | 0.68 | 0.34 | 21.03 |
| Calcium chloride ($CaCl_2$) | ... | ... | ... | 22.23 |
| Magnesium chloride ($MgCl_2$) | ... | ... | ... | 9.68 |
| Potassium sulphate ($K_2SO_4$) | ... | 5.47 | 7.25 | |
| Sodium sulphate ($Na_2SO_4$) | 0.68 | 27.94 | 11.97 | |
| Magnesium sulphate ($MgSO_4$) | ... | 386.11 | 473.67 | |
| Calcium sulphate ($CaSO_4$) | ... | 796.53 | 687.42 | 1.88 |
| Lithium sulphate ($LiSO_4$) | ... | trace | 0.86 | |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | 27.36 | 362.52 | |
| Ferrous sulphate ($Fe_2SO_4$) | ... | 401.74 | 277.87 | |
| Ferric sulphate ($Fe_2SO_4$) | ... | trace | 570.96 | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | ... | 0.51 | ... | trace |
| Potassium bicarbonate ($KHCO_3$) | 1.89 | ... | ... | 3.59 |
| Sodium bicarbonate ($NaHCO_3$) | 3.32 | ... | ... | 24.45 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 11.32 | 60.36 | ... | 0.34 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | ... | ... | 7.01 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 6.66 | ... | ... | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.43 | 86.18 | 64.12 | 0.30 |
| Aluminum oxide ($Al_2O_3$) | ... | ... | ... | trace |
| Manganese oxide ($Mn_2O_3$) | trace | | | |
| Silica ($SiO_2$) | 4.27 | 20.69 | 31.97 | 15.46 |
| Total solids | 31.33 | 1813.57 | 2488.75 | 105.98 |

Pure Spring is a slightly mineralized, calcic, bicarbonated, alkaline (manganic) water, possessing slight diuretic, alterative and antacid properties.

Iron Spring, medicinal classification, weak sulphated 3, weak iron sulphate or (−S3, −FeS). This is a moderately mineralized, ferruginous, calcic and magnesic, sulphated, saline (aluminic) water, possessing marked tonic and alterative properties.

Alum Spring, medicinal classification, weak sulphated 3, weak aluminum sulphate, weak iron sulphate 2 or (−S3, −AlS, −FeS2). This is a moderately mineralized, aluminic, ferruginous, calcic and magnesic sulphated saline water, possessing styptic, tonic and alterative properties.

Magnesic Spring is a lightly mineralized, sodic, bicarbonated and muriated alkaline-saline water, possessing diuretic, antacid and slight tonic properties.

## Gaylord and Gulick Mineral Springs.

*(Tioga County.)*

*Postoffice*, Blossburg. *Location*, in midnorthern Pennsylvania; north of Harrisburg, the capital city, 100 miles; west of Liberty, N. Y., 120

miles. *Situation*, in the Tioga Valley, among the outlying ranges of the Allegheny Mountains, at an altitude of 1500 feet above sea level. The scenic views are pleasing and interesting. *Access*, via the Erie Railway to Blossburg, thence by motor to the springs. *Hotels*, good hotel accommodations in the village. There are 2 springs in this area, 1 of which we present the analysis of below, showing the mineralization:

GAYLORD AND GULICK MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, F. A. Genth). |
|---|---|
| Sodium chloride (NaCl) | 1.71 |
| Lithium sulphate ($Li_2SO_4$) | 2.05 |
| Potassium sulphate ($K_2SO_4$) | 4.10 |
| Sodium sulphate ($Na_2SO_4$) | 534.61 |
| Magnesium sulphate ($MgSO_4$) | 224.01 |
| Calcium sulphate ($CaSO_4$) | 294.52 |
| Manganese sulphate ($MnSO_4$) | 31.29 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 112.51 |
| Cobalt sulphate ($CoSO_4$) | 0.51 |
| Nickel sulphate ($NiSO_4$) | 6.15 |
| Ferric sulphate ($Fe_2SO_4$) | 5.40 |
| Ferric phosphate ($FePO_4$) | 5.47 |
| Silicic acid ($H_2SiO_3$) | 36.76 |
| Sulphuric acid ($H_2SO_4$) | 96.44 |
| Total solids | 1355.53 |

Medicinal classification, weak acid 2.5, weak ferruginous or (−Ac 2.5, −Fe). This is a moderately mineralized, ferric, alumnic, sodic, calcic, sulphated, acid (manganic, ferric, phosphoric) water. This water is rich in ferruginous salts, with accompanying sulphates of magnesium in liberal amounts. The analysis also shows appreciable quantities of the rare salts of manganese, nickel and cobalt. The water possesses diuretic, astringent, slight aperient, tonic and reconstructive properties, and has been found of value in the treatment of anemia and general debility. It has also been found useful in the treatment of chronic diarrhea and dysentery. When applied locally, it exerts appreciable astringent properties. The waters are sold commercially.

## Gettysburg Springs.

(*Adams County.*)

*Postoffice*, Gettysburg. *Location*, in midsouthern Pennsylvania; west of Philadelphia, 115 miles; southwest of Harrisburg, the capital city, 35 miles. *Situation*, these springs issue from faults in the underlying igneous rocks, 2 miles west of the town of Gettysburg, at the foothills of the Catoctin and South Mountains, at an elevations of about 1000 feet above sea level. *Access*, via the Philadelphia & Reading Railway and the Western Maryland Railway, thence by motor 2 miles to the springs. *Hotels*, no definite information available as to

character of accommodations at the spring, but good hotels in the town of Gettysburg. The analysis below shows the mineralization:

GETTYSBURG MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, F. A. Genth). Katalysin Spring. | Lithia Spring. |
|---|---|---|
| Lithium chloride (LiCl) | trace | trace |
| Sodium chloride (NaCl) | 11.38 | 5.47 |
| Potassium sulphate ($K_2SO_4$) | 3.59 | 3.56 |
| Sodium sulphate ($Na_2SO_4$) | 14.19 | |
| Calcium sulphate ($CaSO_4$) | 42.23 | 8.20 |
| Strontium sulphate ($SrSO_4$) | trace | |
| Magnesium sulphate ($MgSO_4$) | 13.33 | 59.85 |
| Barium sulphate ($BaSO_4$) | trace | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.17 | 0.17 |
| Sodium bicarbonate ($NaHCO_3$) | 11.91 | 57.79 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 280.51 | 170.31 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 9.23 | 99.69 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 0.17 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.68 | 0.68 |
| Magnesium borate ($MgBO_4$) | 0.51 | 0.34 |
| Calcium fluoride (CaF) | 0.17 | |
| Silica ($SiO_2$) | 34.71 | 30.09 |
| Total solids | 421.78 | 436.15 |

Katalysin Spring, medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, calcic, bicarbonated, sulphated alkaline (manganic) water, possessing diuretic, antacid and slight tonic properties. The water is said to be useful in the treatment of gastric disturbances due to acidity and in rheumatism, gout, etc.

Lithia Spring, medicinal classification, weak total mineralization or (−T). This is also a moderately mineralized, sodic, calcic, magnesic bicarbonated alkaline water, carbon-dioxated, possessing diuretic, antacid, antilithic and tonic properties. This water has been used with success in the treatment of disorders of the stomach and in kidney and bladder affections and has been used in the treatment of vesical and renal calculi.

## Minnequa Springs.

### (*Bradford County.*)

*Postoffice,* Minnequa. *Location,* in northern Pennsylvania; south of Elmira, New York, 35 miles; north of Williamsport, 30 miles. *Situation,* at the foothill of Mount Pisga, the highest point in Pennsylvania. The spring issues from the deep igneous rocks below the surface, at an elevation of about 1500 feet above sea level. *Access,* via a branch of the Pennsylvania Railway System. The hotel is a commodious structure, with modern conveniences. Many New York and Philadelphia people have private summer homes nearby. The water, on analysis, reveals the following mineralization:

MINNEQUA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, F. A. Genth). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Sodium chloride (NaCl) | 3.24 |
| Barium sulphate ($BaSO_4$) | trace |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.17 |
| Ammonium nitrate ($NH_4NO_3$) | trace |
| Magnesium borate ($MgBO_4$) | 1.36 |
| Potassium bicarbonate ($KHCO_3$) | 2.39 |
| Sodium bicarbonate ($NaHCO_3$) | 22.74 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 27.18 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 111.66 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 1.02 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 0.17 |
| Zinc bicarbonate ($Zn[HCO_3]_2$) | 0.17 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.68 |
| Aluminum oxide ($Al_2O_3$) | trace |
| Silica ($SiO_2$) | 12.76 |
| Total solids | 183.54 |

This is a lightly mineralized, calcic, sodic, magnesic, bicarbonated alkaline water, carbon-dioxated, possessing slight diuretic, antacid, tonic and reconstructive properties. The water has been used medicinally since its discovery in the early part of the past century. Owing to the presence of manganese, the water has been highly recommended in the treatment of nervous conditions, neurasthenia, epilepsy and chorea.

## Original Magnesia Springs.

(*Crawford County.*)

*Postoffice,* 232 N. Main Street, Cambridge Springs. *Location,* in the northwest corner of the state; north of Pittsburgh, 126 miles; south of Erie, 30 miles; east of Cleveland, O., 137 miles. *Situation,* in the great snow belt, which extends down the Adirondacks, through the northwest corner of the state; elevation, 1300 feet above sea level. *Access,* on the main line of the Erie Railway, with splendid through service east and west. Excellent concrete highways provide easy automobile approach from all directions. *Hotel,* there are several excellent hotels and, besides, a number of cottages. There are several springs here, but the Original Magnesia is the better known, and the only one of which we have an analysis, which shows the following mineralization:

ORIGINAL MAGNESIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. E. Lee). |
|---|---|
| Sodium sulphate ($Na_2SO_4$) | 8.1 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 206.1 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 53.6 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 10.8 |
| Total solids | 278.7 |

This is a lightly mineralized, calcic bicarbonated alkaline (ferruginous) water, carbon-dioxated, and perhaps one of the best of all the carbonated alkaline waters for correcting acid conditions of the stomach. This water should be taken on the advice of a physician. It has been highly recommended in irritation of the genito-urinary tract and as a tonic in anemic states. The climate is variable; in the midwinter the mercury drops around zero, but the air is pure and dry, and delightfully invigorating throughout the year.

### Parker Mineral Springs.

*(McKean County.)*

*Postoffice*, Gardeau. *Location*, in northwestern Pennsylvania; east of Meadville, 90 miles; northwest of Williamsport, 60 miles; north of Altoona, 75 miles; south of Wellsville, New York, 40 miles. *Situation*, in the Allegheny Mountains, on the head waters of a tributary of the Susquehanna. The elevation is about 2000 feet above sea level. *Access*, Gardeau Station, on the Pennsylvania Railway, thence by motor a short distance to the springs. *Hotel*, the hotel sanitarium offers superior accommodations for both the traveler and the chronic invalid. There is ample provision for baths of all kinds. The spring (well), 650 feet deep, flows in a stream at the top at the rate of 70 gallons per hour. The analysis below shows the mineralization:

PARKER MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Henry Trimble). |
|---|---|
| Potassium chloride (KCl) | trace |
| Sodium chloride (NaCl) | 4,831.60 |
| Magnesium chloride ($MgCl_2$) | 1,878.26 |
| Calcium chloride ($CaCl_2$) | 3,794.83 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 331.03 |
| Silica ($SiO_2$) | 22.74 |
| Total solids | 10,858.46 |

Medicinal classification, strong saline or (+Cl). This is a highly mineralized, sodic, calcic, magnesic, muriated, saline water, possessing slight diuretic and cathartic properties. It should be administered in small doses at the beginning; its action stimulates the secretions of the gastric mucous membrane and increases the flow of gastric juice. It is claimed that its best effects are to be noted in atonic dyspepsia, torpor of the liver, constipation and in irritable conditions of the genito-urinary tract. The water is bottled and shipped.

### Pavilion Springs.

*(Berks County.)*

*Postoffice*, Wernersville. *Location*, in the southeastern portion of the state; east of Harrisburg, the capital city, 55 miles; south of

Wilkes-Barre, 65 miles. *Situation*, in the Blue Ridge Mountains, at the foot of South Mountain, at an elevation of 1000 feet above sea level. From Cushion Peak, 1 mile away, with its observatory, one can glimpse a beautiful panorama stretching in all directions from 50 to 75 miles, presenting scenic views of great charm and beauty. *Access*, via Wernersville, on the Philadelphia & Reading Railway, the Central Railway of New Jersey and the Lebanon Valley Railway, thence 2 miles to the hotel and springs. *Hotel*, the hotel is well equipped and luxuriously furnished, open throughout the year. There are a number of springs on the property; we give the analysis of 1 spring:

PAVILION SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, O. Luthy). |
|---|---|
| Sodium chloride ($NaCl$) | 1.1 |
| Potassium sulphate ($K_2SO_4$) | 3.0 |
| Sodium sulphate ($Na_2SO_4$) | 0.3 |
| Sodium bicarbonate ($NaHCO_3$) | 8.9 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 3.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 6.5 |
| Ferric oxide and alumina($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 16.2 |
| Total solids | 39.7 |

The analysis reveals a slightly mineralized, calcic and sodic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic, antacid and tonic effects. The water contains an abundance of free carbonic-dioxide gas and some free oxygen as it flows from the earth. It is a remarkably pure water, and should be of value in digestive disturbances due to hyperacidity, and in disturbances of the bladder and kidneys; it is indicated wherever a mild, bland, pure water is demanded. It is especially suited for home consumption.

## Pulaski Mineral Springs.

(*Lawrence County.*)

*Postoffice*, Farrell. *Location*, in the extreme midwestern portion of the state; northwest of Pittsburgh, 100 miles; northwest of Newcastle, 15 miles; east of Youngstown, O., 17 miles. *Situation*, on the western edge of the Allegheny Valley, in a beautiful, rolling, undulating section of country, well drained, healthy and salubrious. *Access*, via the Erie Railway and the Pennsylvania Railway, thence only a short distance to the spring. *Hotel*, there was at one time a large hotel conducted in connection with the springs, but it was destroyed by fire and never rebuilt. The following analysis shows the mineralization:

PULASKI MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, F. T. Aschman, Ph.B.). |
|---|---|
| Potassium chloride (KCl) | 41.2047 |
| Sodium chloride (NaCl) | 2761.3254 |
| Sodium bromide (NaBr) | 13.7791 |
| Calcium sulphate ($CaSO_4$) | 2.0520 |
| Lithium bicarbonate ($LiHCO_3$) | traces |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 63.5094 |
| Ferric bicarbonate ($Fe[HCO_3]_2$) | 17.5104 |
| Aluminum oxide ($Al_2O_3$) | 1.4877 |
| Silica ($SiO_2$) | 10.3626 |
| Total solids | 2901.2313 |

Medicinal classification, saline or (Cl). This is a moderately highly mineralized, sodic muriated saline (bromic, ferruginous) water, carbon-dioxated, possessing diuretic, aperient and tonic properties. It flows from the earth bright and sparkling, and is a delightful table beverage. It has some local reputation with the profession as of value in certain stomach and bowel disorders, and in irritations of the genito-urinary tract. The waters have been bottled and shipped for the past thirty years.

## Rosscommon Spring.

(*Monroe County.*)

*Postoffice*, Wind Gap (and Bethlehem). *Location*, in eastern Pennsylvania; southwest of the Delaware Water Gap, 15 miles; south of Stroudsburg, 12 miles; north of Easton, 10 miles. *Situation*, in the "wind gap," on the north incline of the Blue Ridge Mountains, at an elevation of 1200 feet above tide water. *Access*, via the Philadelphia & Reading Railway to Rosscommon Station, only a few hundred yards from the hotel. *Hotel*, the accommodations are unpretentious, but quite home-like and comfortable, with some modern conveniences. The water issues from a fissure in the igneous rock at the bottom of the spring, and constantly discharges a large volume of carbonic-acid gas. The analysis below shows the mineralization:

ROSSCOMMON SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. H. Chandler). |
|---|---|
| Sodium chloride (NaCl) | 1.4 |
| Potassium sulphate ($K_2SO_4$) | 0.8 |
| Sodium sulphate ($Na_2SO_4$) | 1.5 |
| Magnesium sulphate ($MgSO_4$) | 0.4 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 2.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 10.7 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.1 |
| Silica ($SiO_2$) | 8.1 |
| Total solids | 25.7 |
| Gases: | |
| Carbon dioxide, cc. per liter | 4.8 |

The analysis shows this to be a very slightly mineralized, calcic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic properties. This water is remarkable for its low mineralization and purity. It is one of the few lowly mineralized waters in this country. Paradise Spring, in Maine, has a mineralization of 20.24 parts per 1,000,000. The waters of Bela Lake, Wales, has a mineralization of total solids, 27.86 parts per 1,000,000,; Lock Katrine, Scotland, has a mineralization of total solids, 17.86 parts per 1,000,000; Paradise Spring is lower in total solids than any spring in this country.

## Saegerstown Mineral Springs.

*(Crawford County.)*

*Postoffice*, Saegerstown. *Location*, in northwestern Pennsylvania; north of Pittsburgh, 90 miles; south of Erie, 30 miles; west of Bradford, 75 miles. *Situation*, in the valley of the historic Venango River, now called French Creek, at an elevation of 1200 feet above sea level. *Access*, via the Erie Railway to Saegerstown, thence a short distance by motor to the springs. *Hotel*, there is a combined hotel and sanitarium, commodious and comfortable, with modern conveniences, open throughout the year. The springs issue from igneous rock, 300 feet below the surface. The analysis shows the following mineralization:

SAEGERSTOWN MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. H. Dean). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 127.56 |
| Potassium sulphate ($K_2SO_4$) | 3.76 |
| Sodium sulphate ($Na_2SO_4$) | 10.60 |
| Calcium sulphate ($CaSO_4$) | 70.04 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 78.95 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 90.30 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.56 |
| Silica ($SiO_2$) | 71.30 |
| Total solids | 459.07 |

Medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, sodic, muriated and calcic bicarbonated alkaline-saline water, possessing diuretic, antacid and very slight aperient properties. The waters are bottled and shipped extensively. They are used in diseased conditions benefited by this class of waters, and have some reputation in gastric disturbances and in the treatment of bladder and kidney affections.

## Three Springs.

*(Huntingdon County.)*

*Postoffice*, Three Springs. *Location*, in midsouthern Pennsylvania; west of Harrisburg, the capital city, 60 miles; east of Johnstown, 50

miles. *Situation*, in a beautiful valley, lying between Jocks Mountain, 2200 feet high, and Cove Hill, 2210 feet in altitude, surrounded by heavily forested hills and beautiful valleys. *Access*, via the Pennsylvania Railway System. *Hotel*, there is a good hotel and sanitarium, with all modern conveniences. The springs, 3 in number, are situated about 100 feet apart, forming the corners of an equilateral triangle, and are designated as Springs Nos. 1, 2 and 3. We give the analysis of Spring No. 1, which shows the mineralization:

THREE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. G. Pond). |
|---|---|
| Sodium chloride ($NaCl$) | 5.98 |
| Lithium sulphate ($Li_2SO_4$) | 0.34 |
| Potassium sulphate ($K_2SO_4$) | trace |
| Sodium sulphate ($Na_2SO_4$) | 101.06 |
| Magnesium sulphate ($MgSO_4$) | 573.53 |
| Calcium sulphate ($CaSO_4$) | 926.79 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 941.86 |
| Silica ($SiO_2$) | 19.68 |
| Total solids | 2569.24 |
| Gases: | |
| Carbon dioxide, cc. per liter | 18.8 |
| Oxygen, cc. per liter | 5.9 |
| Nitrogen, cc. per liter | 13.3 |

Medicinal classification, weak alkaline b2, weak calcic sulphate 4 or (−Ab2, −CaS4). This is a moderately highly mineralized, calcic, magnesic, sodic, sulphated and bicarbonated, saline water, carbon-dioxated, oxygenated, azotized, possessing diuretic and laxative properties. The use of this water has been found very efficient when activity of the emunctories is desirable. The sulphate ions are present in solution in sufficient quantity to stimulate intestinal activity and also to stimulate the hepatic function. The water has been used in the successful treatment of obesity and in uremia and general anasarca. It is also beneficial in other disorders requiring a sulphated saline water.

## Valley Forge Springs.

(*Chester County.*)

*Postoffice*, Valley Forge. *Location*, in the southeast corner of the state; northwest of Philadelphia, 25 miles; northeast from Wilmington, Del., about 50 miles. *Situation*, in Schuylkill Township, near the historical Valley Forge of Revolutionary fame, amid the hills and dales of a beautiful picturesque region, at an elevation of 750 feet above sea level. *Access*, via the Philadelphia & Reading Railroad; only about fifteen minutes walk to the springs. *Hotel*, no accommodations at present for permanent guests, but many distinguished persons have visited Valley Forge Treasure Farm, for besides the health-

giving waters, semiprecious stones are found all over the farm, which has interested mineralogists and geologists, even in foreign countries. The geological formation under the earth's surface at Valley Forge Spring from above downward are, first, a strata of clay-loam conglomerates, below this a heavy layer impervious to surface water, next comes a heavy stratum of Potsdam sand overlying coarse Potsdam gravel, next is the heavy Potsdam rock, which volcanic disturbances long ages ago disrupted, leaving faults and fissures, through which the health-giving waters are sent upward by the effects of hydrostatic pressure, and reach the surface as springs. There are several springs on the property designated Spring Nos. 1, 2, 3, 4 and 5. The more important are the following, of which we present analyses:

VALLEY FORGE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Booth, Barrett & Blair). Alkaline Spring. | Limewater Spring. |
|---|---|---|
| Sodium chloride ($NaCl$) | 4.1 | 6.6 |
| Sodium sulphate ($Na_2SO_4$) | 3.8 | 7.2 |
| Magnesium sulphate ($MgSO_4$) | 15.0 | |
| Sodium nitrate ($NaNO_3$) | 1.8 | 1.2 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 1.3 | 14.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 34.8 | 32.4 |
| Aluminum oxide ($Al_2O_3$) | 0.8 | 0.5 |
| Ferric oxide ($Fe_2O_3$) | ... | 0.1 |
| Silica ($SiO_2$) | 4.0 | 16.0 |
| Total solids | 65.6 | 78.6 |

Alkaline Spring is a very slightly mineralized, calcic, bicarbonated and magnesic, sulphated alkaline water, possessing diuretic and antacid properties.

Lime Water Spring is a very slightly mineralized, calcic magnesic, bicarbonated, alkaline water, possessing diuretic and antacid properties. These waters are remarkable for their low mineralization and freedom from contamination. They are both pure, wholesome, potable waters and quite desirable for table use, and are useful in the sick room wherever a pure, wholesome water is indicated. Besides the above springs there is a valuable iron spring, which is highly appreciated by local physicians, who endorse and freely prescribe the waters. The situation, climatic conditions and ease of access make this an ideal spot for a rest-cure sanitarium.

The following springs have been used as resorts:

*Bedford Chalybeate Spring, P. O.*, Bedford, Bedford County. This spring arises in a beautiful 14-acre park. The Hotel Chalybeate, a home-like house with accommodations for 150 guests, is beautifully

situated amid this park. There are 3 springs in this area, but no definite information nor satisfactory analysis available.

*Black Barren Mineral Spring, P. O.*, Pleasant Grove, Lancaster County. The location is in the valley of the Susquehanna River, about 3 miles north of the Maryland line, at an altitude of 600 feet above sea level. Repeated correspondence failed to elicit any definite information or satisfactory analysis.

*Carlisle Springs, P. O.*, Carlisle Springs, Cumberland County. The springs issue from the base of the Blue Mountains, 18 miles southwest of Carlisle. The place is said to have had a good hotel. No definite information nor satisfactory analysis available.

*Frankfort Mineral Springs, P. O.*, Frankfort Springs, Beaver County. The Frankfort Springs Inn is said to have been a well-kept resort hotel. No definite information nor satisfactory analysis available; repeated correspondence failed to elicit any information that was trustworthy.

*Glen Summit Springs, P. O.*, Glen Summit, Luzerne County. Location, 125 miles from Philadelphia, on the summit of the Nescopec Mountains, 2000 feet above sea level. The place is said to have been a popular resort in bygone days. There are a number of springs in the area, but no definite information nor satisfactory analysis available.

*Ponce de Leon Springs, P. O.*, Meadville, Crawford County. The location is said to be particularly pleasing for a summer resort, 1200 feet above sea level. There are 6 springs in the area, but no definite information nor satisfactory analysis available.

*White Sulphur Springs, P. O.*, Mann's Choice, Bedford County. This spring is located 10 miles southwest of Bedford Springs. The elevation is 1500 feet above sea level. There are 2 springs in the area. No definite information nor satisfactory analysis available.

*York Sulphur Springs, P. O.*, York Sulphur Springs, Adams County. This was one of the older Pennsylvania spring resorts. It is said to have been popular with the citizens of Baltimore since its discovery, in 1790. There are 2 springs in the area, but no definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Carnegie Alkaline Mineral Spring, P. O.*, Carnegie, Allegheny County.

*Chadwick Mineral Well, P. O.*, Cambridge Springs, Crawford County.

*Crystal Rock Spring, P. O.*, Temple, Berks County.

*Dark Hollow Spring, P. O.*, Oakmont, Allegheny County.

*Ephrata Mountain Crystal Spring, P. O.*, Ephrata, Lancaster County.

*Great Oak Spring, P. O.*, Shenkel, Chester County.

*Juniata Springs, P. O.*, Altoona, Blair County.

*Kecksburg Artesian Mineral Springs, P. O.*, Mammoth, Westmoreland County.

*Keystone Spring, P. O.*, Taylorsville, Bucks County.
*Mountain Spring, P. O.*, Easton, Northampton County.
*Mountain Springs, P. O.*, Reading, Berks County.
*Mount Laurel Springs, P. O.*, Temple, Berks County.
*Polar Springs, P. O.*, Morrisville, Bucks County.
*Pulaski Mineral Spring, P. O.*, Pulaski, Lawrence County.
*Shawnee Mineral Springs, P. O.*, Plymouth, Luzerne County.
*Thurston's Carbonate Spring, P. O.*, Meadville, Crawford County.
*Tuckhoe Mineral Spring, P. O.*, Northumberland, Northumberland County.
*West Nanticoke Artesian Well, P. O.*, West Nanticoke, Luzerne County.
*White Ribbon Mineral Well, P. O.*, Harrison Valley, Potter County.
*White Star Spring, P. O.*, Easton, Northampton County.

## RHODE ISLAND.

Rhode Island extends from 41°18′ to 42°5′ north latitude and from 71°8′ to 71°53′ west longitude, and comprises an area of 1250 square miles, of which 197 square miles are covered with water. The extreme length of the state from north to south is 46 miles, and the extreme width from east to west is 36 miles. The surface of the state is broken and hilly; the greater portion of its area is covered by the eastern Appalachian Belt; though rugged and hilly, the general elevation is not great, being less than 600 feet above sea level. The highest point in the state is Dufree Hill, in the northwestern part its altitude is 805 feet. The climate is mild and equable compared with the rest of New England. It is influenced chiefly by the winds coming from the Gulf Stream. The mean temperature for January is 2.2° C. (36° F.); for July, 24.4° C. (76° F.). The state includes within its limits many beautiful and attractive summer resorts, prominent among which are Newport, the "queen" of American watering places. Narragansett Pier, Watch Hill and Block Island are popular places much frequented.

Rhode Island has 6 spring localities, with a total of 17 individual springs, 2 of which have been analyzed and none used as resorts. The older writers do not mention any spring localities within the state, Crook mentions only 4 and Peale records 6. The record of mineral springs for this state is somewhat meager and, so far as we can learn, the springs in this area are of comparatively little importance. From available information, it seems that the few springs analyzed are of the alkaline, calcic and chalybeate class.

### Gladstone Spring.

(*Washington County.*)

*Postoffice*, Naragansett Pier. *Location*, in eastern Rhode Island; south of Providence, the capital city, 28 miles; east of Westerly, 21 miles. *Situation*, on the coastal border of Naragansett Pier, just

south of Naragansett Bay and overlooking the Atlantic Ocean. This is one of the most fashionable resorts on the Atlantic Coast; here congregate the leaders of culture and fashion early in the season, and they remain until the end of October. *Access*, via the New York, New Haven & Hartford Railway System and connecting lines, or by motor over splendid macadam highways, which intersect this whole region. *Hotel*, there are splendid hotel accommodations at the Pier. The spring is located near the Pier, and the following analysis shows the mineralization:

GLADSTONE SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 3.26 |
| Sodium chloride (NaCl) | 20.40 |
| Sodium sulphate ($Na_2SO_4$) | 5.60 |
| Magnesium sulphate ($MgSO_4$) | 4.50 |
| Sodium nitrate ($NaNO_3$) | 3.70 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 9.60 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 22.20 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.90 |
| Silica ($SiO_2$) | 15.40 |
| Total solids | 85.56 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 6.9 |
| Carbon dioxide set free on evaporation | 4.5 |
| Temperature, °C. | 10 |
| Flow in gallons per day | 50,000 |

The analysis shows this to be a very lightly mineralized, sodic, muriated, calcic, bicarbonated, alkaline-saline water. Practically 37 per cent of the salts in solution are in the form of the bicarbonates of calcium and magnesium and 36 per cent are present as chlorides of sodium and potassium and the sulphates of sodium and magnesium. It is recommended for table and club purposes.

## Ochee Spring.

### (*Providence County.*)

*Postoffice*, Johnson, via Providence. *Location*, eastern-central Rhode Island; only 3 miles from Providence, the capital city; south of Woonsocket, 14 miles. *Situation*, in a rough, hilly section of country, at an elevation of about 400 feet above sea level. *Access*, via the New York, New Haven & Hartford Railway System, and by the splendid macadam highways which intersect this region, a pleasure to motorists. *Hotel*, there are no accommodations at the spring; it is not run as a resort, but there are good accommodations at Providence. There are several springs in this area, but the analysis below shows the mineralization of the most important spring.

OCHEE SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 6.10 |
| Sodium chloride (NaCl) | 0.72 |
| Sodium sulphate ($Na_2SO_4$) | 10.95 |
| Magnesium sulphate ($MgSO_4$) | 3.26 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium nitrate ($NaNO_3$) | 2.47 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 17.67 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 54.29 |
| Ferric oxide ($Fe_2O_3$) | 0.90 |
| Calcium silicate ($CaSiO_3$) | 0.69 |
| Silica ($SiO_2$) | 14.62 |
| Total solids | 112.67 |
| Temperature, °C. | 10 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 4.4 |
| Carbon dioxide set free on evaporation | 10.1 |
| Flow in gallons per day | 86,400 |

The analysis shows this to be a lightly mineralized, calcic and magnesic bicarbonated alkaline water, possessing diuretic and slight antacid properties. When used continuously and in large quantities it would exert mild aperient action. It has been accorded some local reputation as an auxiliary in the treatment of kidney, liver and the milder forms of digestive disorders. The waters are bottled and shipped.

The following springs were used as resorts.

*Darling's Mineral Springs, P. O.*, Pawtucket, Providence County. More than a half century ago this place had quite a reputation as a resort. A great many people resorted to this spot, believing the water as good as any at Saratoga; but for want of publicity, the place has been allowed to pass into innocuous desuetude. No definite information nor satisfactory analysis available.

*Cumberland Springs, P. O.*, Cumberland Hill, Providence County. No definite information nor satisfactory analysis available.

*Warwick Neck Mineral Springs, P. O.*, Warwick Neck, Kent County. This is said to be an iron water, but no definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Berry Spring, P. O.*, Pawtucket, Providence County.

*Girard Spring, P. O.*, North Providence, Providence County.

*Prophet Spring, P. O.*, Providence, Providence County.

## SOUTH CAROLINA.

*South Carolina* extends from 32° to 35° north latitude and from 78°35′ to 88°30′ west longitude, and comprises an area of 30,570 square

miles, of which 400 square miles are covered with water. The state is triangular in shape, with a base measuring 190 miles in a straight line, fronting the ocean, and an apex, 240 miles inland. The state is level and marshy along the coast, while the interior and western sections are undulating hills. The Coastal Plain extends 100 miles inland, and nowhere is more than 500 feet above sea level. The Piedmont Plain rises from its eastern margin of 500 feet to as high as 1000 feet at the extreme northwest. Here the Blue Ridge, whose crest forms the northwestern boundary rises abruptly 2000 feet higher. Kings Mountain has an elevation of 1692 feet; Paris Mountain, 2054 feet; Table Rock, 3000 feet; Mount Pinnacle, 3436 feet. The mountain regions abound in beautiful picturesque scenery, rendering it pleasing and attractive to the tourist. The climate is mild and delightful, resembling that of southern Europe. It is especially healthful in the uplands and pine barrens, but not so salubrious in the low swamp regions. The mean annual temperature ranges from 15.6° C. (60° F.) in the north to 19° C. (67° F.) in the south; the maximum is about 41.1° C. (106° F.), and a temperature of 16.8° C. (62.1° F.) has been observed in the northwest highlands.

South Carolina has 31 spring localities, with a total of 39 individual springs, of which 6 have been analyzed and at various times 8 have been used as resorts. Walton lists 2 spring localities and Crook mentions 7. Many of the resorts well known fifty years ago have fallen into innocuous desuetude. The following list has been secured from personal visitation and from correspondence with physicians and spring owners.

### Ambler Springs.

(*Pickens County.*)

*Postoffice*, Pickens. *Location*, in northwestern South Carolina; west of Rock Hill, 110 miles; northwest of Columbia, the capital city, 120 miles. *Situation*, among the foothills on the southeastern slope of the Blue Ridge Mountains, at an elevation of 2000 feet above sea level. *Access*, via the Southern Railway System to Easly, S. C., thence by a branch line into Pickens Court House, thence by motor 7 miles to the springs. *Hotel*, the hotel is about 1 mile from the springs, and offers some conveniences. There are 2 springs in the area, 1 of which we give the analysis below:

AMBLER SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, M. B. Hardin). |
|---|---|
| Sodium chloride ($NaCl$) | 6.33 |
| Potassium sulphate ($K_2SO_4$) | 8.72 |
| Sodium sulphate ($Na_2SO_4$) | 6.33 |
| Sodium bicarbonate ($NaHCO_3$) | 22.11 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 18.02 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 59.59 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.34 |
| Silica ($SiO_2$) | 24.46 |
| Total solids | 145.90 |

The analysis shows this to be a very lightly mineralized, calcic and sodic, bicarbonated, alkaline water, possessing diuretic, slight antacid and tonic properties. It is claimed that this water has been used with success in the treatment of digestive disorders and also in the treatment of chronic skin disorders of the eczematous type. The water has been bottled and shipped for a number of years, and seems to have earned for itself quite a reputation in the territory adjacent to the springs.

### Charleston Artesian Wells.

*(Charleston County.)*

*Postoffice*, Charleston. *Location*, on the seacoast and at the principal seaport of South Carolina; about midway between Cape Hatteras, N. C., and Jacksonville, Fla. *Situation*, in the quaint old city of Charleston, overlooking the Atlantic Ocean. *Access*, via the Atlantic Coast Line Railway and the Southern Railway System and by ocean steamers from New York. *Hotel*, there are several splendid hotels in the city. The analyses below shows the mineralization of 4 of the wells:

CHARLESTON ARTESIAN WELLS.

| Hypothetical combinations. | Parts per 1,000,000. | | | |
|---|---|---|---|---|
| | Analyst, C. U. Sheppard. | Analyst, C. T. Robinson. | Analyst, W. Robertson. | |
| | Old Artesian Well. | Citadel Green Well. | Cotton Press Well. | Chislom Mill Well. |
| Sodium chloride ($NaCl$) | 1084.43 | 194.88 | ... | 2372.02 |
| Magnesium chloride ($MgCl_2$) | ... | 3.94 | 33.88 | 82.98 |
| Potassium sulphate ($K_2SO_4$) | ... | ... | ... | 328.68 |
| Calcium sulphate ($CaSO_4$) | ... | 7.52 | 181.70 | 70.49 |
| Magnesium sulphate ($MgSO_4$) | ... | 2.90 | 237.48 | 48.25 |
| Sodium nitrate ($NaNO_3$) | ... | 9.41 | | |
| Sodium bicarbonate ($NaHCO_3$) | 1215.83 | 1309.96 | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 0.34 | | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 2.05 | ... | 727.33 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 9.42 | | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace | | | |
| Sodium silicate ($Na_2SiO_3$) | trace | 43.11 | 3497.46 | 11.29 |
| Silica ($SiO_2$) | trace | 6.16 | 125.75 | 40.03 |
| Loss | ... | ... | ... | 13.17 |
| Total solids | 2312.65 | 1587.30 | 4803.60 | 2956.91 |

Old Artesian Well, medicinal classification, weak alkaline a3, weak saline 3 or (−Aa3, −Cl 3). This is a moderately highly mineralized, sodic, bicarbonated and muriated alkaline-saline water.

Citadel Green Well, medicinal classification, weak alkaline a3 or (−Aa3). This is a moderately mineralized, sodic bicarbonated and muriated alkaline-saline water.

Cotton Press Well, medicinal classification, alkaline-silicate 3 or (ASil3). This is a moderately highly mineralized, calcic bicarbonated and sulphated, alkaline-saline (silicious) water.

Chislom Well, medicinal classification, saline or (Cl). This is a moderately mineralized, sodic muriated, saline water.

## Chick's Springs.

*(Greenville County.)*

*Postoffice*, Chick's Springs, via Greenville. *Location*, in northwestern South Carolina; northwest of Columbia, the capital city, 110 miles; north of Augusta, Ga., 100 miles; south of Asheville, N. C., 55 miles. *Situation*, among the immediate foothills on the southwestern slope of the Blue Ridge Mountains, at an elevation of 1200 feet above sea level. *Access*, via Taylor Station, on the Southern Railway, thence by motor 1 mile to the springs. *Hotel*, there is a small hotel and a few cottages, with some conveniences, and we understand plans are under way for extensive improvements. The climate is delightful, the scenery magnificent and the air is dry and bracing. There are 2 springs in this area, 1 sulphur and 1 iron, the analysis of the latter is given below, showing the mineralization:

CHICK'S SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. C. U. Sheppard). |
|---|---|
| Sodium sulphate ($Na_2SO_4$) | 40.55 |
| Magnesium sulphate ($MgSO_4$) | 10.77 |
| Calcium sulphate ($CaSO_4$) | 557.27 |
| Ferric oxide ($Fe_2O_3$) | 7.02 |
| Potassium silicate ($KSiO_3$) | 5.30 |
| Sodium silicate ($NaSiO_3$) | 63.14 |
| Silica ($SiO_2$) | 8.56 |
| Total solids | 692.61 |

Medicinal classification, weak calcic sulphate or (−CaS). The analysis shows this to be a moderately mineralized, calcic, sulphated saline water, possessing diuretic and tonic properties. These waters are highly endorsed by local physicians in the treatment of atonic digestive disturbances, when accompanied by hepatic congestion. The waters are bottled and shipped extensively.

## Glenn Springs.

*(Spartanburg County.)*

*Postoffice*, Glenn Springs. *Location*, in the northwest section of the state; northwest of Columbia, the capital city, 75 miles; west of Cheraw, 120 miles; north of Augusta, Ga., 90 miles; south of Shelby, N. C., 32 miles. *Situation*, among the foothills of the Blue Ridge Mountains, at an elevation of 1000 feet above sea level. *Access*, via

Glenn Springs Station, on the Atlantic Coast Line Railway, thence only a short distance to the springs. *Hotel,* the hotel is a modern resort hostelry. The springs issue from a fault in the igneous rocks below the sandstone formation above. The analysis herewith shows the mineralization:

GLENN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. C. U. Sheppard). |
|---|---|
| Potassium chloride (KCl) | 9.19 |
| Sodium chloride (NaCl) | 37.81 |
| Calcium sulphate ($CaSO_4$) | 1555.56 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 93.02 |
| Lithium bicarbonate ($LiHCO_3$) | Heavy trace |
| Silica ($SiO_2$) | 13.00 |
| Total solids | 1708.58 |

Medicinal classification, weak calcic sulphate 4 or (−CaS4). This is a moderately mineralized, calcic, sulphated, alkaline-saline water, possessing diuretic and antacid properties. The medical profession of the state highly endorses the water, especially in disorders of the alimentary tract, diarrhea, dysentery and hemorrhoids. The water is also said to be useful in digestive disturbances. The sulphate ions ought to excite bowel action if the water is taken in large quantities.

## Harris Lithia Springs.

(*Laurens County.*)

*Postoffice,* Waterloo. *Location,* northwest of central South Carolina; northwest of Columbia, the capital city, 60 miles; south of Spartanburg, 40 miles; north of Augusta, Ga., 60 miles. *Situation,* in a delightful little valley, through which runs a small stream, lying at the foothills of the outlying spurs of the Blue Ridge Mountains, at an elevation of about 900 feet above sea level. *Access,* via the Cross Hill Station, on the Seaboard Air Line Railway, thence a distance of 2 miles to the springs; via Waterloo Station, on the Charleston & Western Railway, thence 1½ miles to the springs. *Hotel,* the hotel is a modern commodious resort hostelry, open from June 1 to October 1. The analysis below shows the mineralization:

HARRIS LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. R. O. Doremus). |
|---|---|
| Sodium chloride (NaCl) | 13.00 |
| Potassium sulphate ($K_2SO_4$) | 8.72 |
| Sodium sulphate ($Na_2SO_4$) | 9.92 |
| Calcium sulphate ($CaSO_4$) | 1426.63 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 41.40 |
| Lithium bicarbonate ($LiHCO_3$) | 39.69 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 52.01 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 5.48 |
| Silica ($SiO_2$) | 42.95 |
| Total solids | 1619.80 |

Medicinal classification, weak calcic sulphate 4 or (−CaS4). The analysis shows this to be a moderately mineralized, calcic, sulphated, alkaline-saline water, possessing diuretic, slight antacid, antilithic, solvent and tonic properties. This water is highly endorsed in gastric disorders due to acidity and hyperacidity, and has had some success in the treatment of rheumatism. It is highly recommended in uric acid, renal and vesical calculi, and it is said to cause a notable reduction of sugar in diabetes. The waters are bottled and shipped extensively. It is highly effervescent and agreeable to the taste.

### Shivar Springs.

(*Fairfield County.*)

*Postoffice*, Shelton. *Location*, to the north of the central section of the state of South Carolina; north of Columbia, the capital city, 38 miles; southwest of Spartanburg, 50 miles; east of Anderson, 70 miles. *Situation*, on the outer eastern edge of the valley of the Broad River, at the eastern foothills of the Blue Ridge Mountains, at an elevation of about 850 feet above sea level. *Access*, via Shelton, on the Southern Railway, thence by motor a short distance to the springs. *Hotel*, there are no accommodations for guests. The spring issues from a fault in the underlying igneous rocks and comes to the surface sparkling with life. The analysis herewith shows the mineralization:

SHIVAR SPRINGS.

| Hypothetical combinations. | Prats per 1,000,000 (Analyst, F. L. Parker, M.D.). |
|---|---|
| Potassium chloride (KCl) | 16.43 |
| Sodium chloride (NaCl) | 56.64 |
| Magnesium chloride ($MgCl_2$) | 32.85 |
| Magnesium sulphate ($MgSO_4$) | 49.28 |
| Calcium sulphate ($CaSO_4$) | 43.29 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 243.65 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.91 |
| Silica ($SiO_2$) | 36.10 |
| Total solids | 451.16 |

Medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, calcic, bicarbonated and sulphated, alkaline water, possessing diuretic, antacid, alterative and tonic properties. The water is highly endorsed by physicians in diseases of the stomach, liver, kidneys and bladder, rheumatism, neuralgia, sciatica, etc. It has been used with success in the treatment of renal and vesical calculi. The iron content makes it a valuable tonic in anemia and chlorosis and in run-down conditions where an iron tonic is indicated. There is sufficient sulphate radicles in solution to produce a cathartic action when taken in sufficient quantities. The water is bottled and shipped extensively throughout the United States.

The following springs were once used as resorts:

*Cherokee Springs, P. O.*, Spartanburg, Spartanburg County. This is said to be a chalybeate water, but no definite information nor satisfactory analysis available.

*Garret Spring, P. O.*, Spartanburg, Spartanburg County. This is said to be a calcic sulphuretted water, but no definite information nor satisfactory analysis available.

*Reedy Creek Springs, P. O.*, Latta, Marion County. This resort is located in a region forested with the long-leaf pine and enjoyed quite a reputation some thirty years ago. Hotels and cottages, etc. No definite information nor satisfactory analysis available.

*West Springs, P. O.*, West Springs, Union County. Location, 12 miles southeast of Glen Springs, at an elevation of about 2000 feet above sea level. Hotels and cottages, etc. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Belleview Mineral Springs, P. O.*, Columbia, Richland County.

*Glendale Mineral Spring, P. O.*, Bamberg, Bamberg County.

*Mansfield Mineral Spring, P. O.*, Spartanburg, Spartanburg County.

*Mertin's Crystal Spring, P. O.*, Augusta, Ga., Aiken County.

## SOUTH DAKOTA.

South Dakota extends 43° to 46° north latitude and from 96°22′30″ to 104° west longitude, and comprises an area of 77,650 square miles, of which 800 square miles are covered by water. The distance across the state from east to west is 380 miles and from north to south the distance is 200 miles. The surface of the state is a rolling prairie, serried by numerous water courses. The Black Hills, situated in the southwestern portion of the state and reaching into Wyoming, have a considerable elevation, reaching a height of 7000 feet. The Bad Lands in this section are a remarkable region of steep hills and precipitous bluffs, with a labyrinth of deep ravines carved out by rapid erosion. The state is thickly studded with many beautiful lakes of glacial formation. The largest is Big Stone and Traverse, on the northwestern boundary. The climate, though subject to great extremes, varying from 1.1° C. (34° F.) in winter to 39° C. (103° F.) in summer, is healthful and invigorating. Sometimes in midwinter the mercury may drop to −40.4° C. (40° F. below zero). But the heat of summer and the cold of winter are much more endurable than the more moderate temperature of the eastern states, owing to the dryness of the atmosphere, which renders the climate bracing and pleasant.

South Dakota has a number of mineral spring localities and several springs of decided value medicinally. The information available concerning the springs in this state is meager; Crook mentions only 1 locality. South Dakota reported 3 springs selling waters during the year 1923.

## Battle Mountain Mammoth Spring.

(*Fall River County.*)

*Postoffice,* Hot Springs. *Location,* in the southeastern portion of the state; south of Deadwood, 70 miles; southwest of Pierre, the capital city, 165 miles. *Situation,* on the slope of the historic Battle Mountain, 5000 feet above sea level, overlooking the beautiful valley of the Minnekahta, all sheltered by a wall of rugged ranges of the celebrated South Dakota Black Hills. *Access,* via the Chicago & Northwestern Railway and the Chicago, Burlington & Quincy Railway, thence a short motor drive to the sanitarium. *Hotel,* the U. S. Government has acquired title to an area of 6 square miles and erected a home for disabled soldiers and sailors, known as the Battle Mountain Sanitarium. The Mammoth Spring, included in the Government's area, on analysis shows the following mineralization:

MAMMOTH SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. C. B. Gibson). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.34 |
| Calcium chloride ($CaCl_2$) | 95.58 |
| Magnesium chloride ($MgCl_2$) | 70.28 |
| Potassium sulphate ($K_2SO_4$) | 96.27 |
| Sodium sulphate ($Na_2SO_4$) | 397.74 |
| Calcium sulphate ($CaSO_4$) | 617.48 |
| Magnesium phosphate ($MgPO_4$) | 1.71 |
| Magnesium nitrate ($MgNO_3$) | 5.13 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 97.23 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 7.16 |
| Silica ($SiO_2$) | 36.50 |
| Organic matter | 62.01 |
| Total solids | 1487.43 |

Medicinal classification, weak calcic sulphated 3 or (−CaS3). This is a moderately mineralized, calcic, sodic and potassic, sulphated saline water, sulphuretted, possessing diuretic, slight laxative and tonic properties, and should be of value in the treatment of catarrhal disorders of the bowels, liver and biliary passages. It has been highly endorsed in the treatment of gout, rheumatism and arthritic disturbances. These springs were the resort of the Indians long before the white man found his way into the "jealously guarded realms of the Black Hills," and were considered by the red men as a panacea for all ills. Their fame had penetrated to the confines of civilization long before the advancing wave of white settlers had driven the Indians further into the forests.

## Braun Mineral Springs.

(*Fall River County.*)

*Postoffice,* Hot Springs. *Location,* in the celebrated Black Hills, in southwestern South Dakota; south of Deadwood, 70 miles; north of

Harrison, Neb., 50 miles. *Situation*, in the valley of the Minnekahta, lying 3443 feet above sea level, surrounded by the Black Hills and sheltered with a wall of rugged hills, which encircle this picturesque playground. *Access*, via the Chicago & Northwestern Railway and the Chicago, Burlington & Quincy Railway, and by motor over graded macadam highways, leading through a rough rugged section of the outlying Black Hills presenting scenic views of great beauty and natural charm. *Hotel*, the Braun Hotel and Bath-house is a modern stone and steel structure of pleasing architectural design, offering superior accommodations. Connected with the hotel, and under the same management, is a modernly equipped bathing establishment, fitted with the most approved appliances for the scientific administration of hydrotherapy and balneotherapy. There are several springs in this area, the more important of which we present the following analyses, which shows the mineralization.

BRAUN MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Benton Daless). Braun Spring. | Minnekahta Spring. | Kidney Spring. |
|---|---|---|---|
| Sodium chloride ($NaCl$) | 210.84 | 235.81 | 242.60 |
| Potassium chloride ($KCl$) | ... | ... | 68.44 |
| Magnesium chloride ($MgCl_2$) | ... | ... | 118.00 |
| Sodium sulphate ($Na_2SO_4$) | 295.49 | 277.80 | |
| Magnesium sulphate ($MgSO_4$) | 184.68 | 73.87 | |
| Potassium sulphate ($K_2SO_4$) | ... | 333.62 | |
| Lithium sulphate ($Li_2SO_4$) | ... | ... | 15.21 |
| Calcium sulphate ($CaSO_4$) | ... | 279.24 | 703.99 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 539.84 | | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | ... | ... | 2.76 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.03 | trace | trace |
| Silica ($SiO_2$) | 5.64 | 42.04 | 23.64 |
| Total solids | 1237.52 | 1242.38 | 1174.64 |
| Temperature, °C. | 31.1 | 36.7 | |
| Flow in gallons per day | 60,000 | 100,000 | |

Braun Spring, medicinal classification, weak alkaline b, weak sulphated or (−Ab, −S). This is a moderately mineralized, thermic, calcic, bicarbonated, sodic and magnesic, sulphated, alkaline-saline water, sulphuretted, possessing diuretic and tonic properties. This water has been found useful in the treatment of chronic diseases of the gastro-intestinal tract, diseases of the liver and biliary passages and in rheumatism and arthritic joint disturbances, etc.

Minnekahta Spring, medicinal classification, weak sulphated 2 or (−S2), thermic. This is a moderately highly mineralized, thermic, potassic, calcic, sodic, magnesic, sulphated saline water, sulphuretted, possessing laxative properties. This water has been found useful in the treatment of chronic disorders of the gastro-intestinal tract, diseases of the liver and bile ducts, chronic diseases of the integumen-

tary system, gout, rheumatism and nervous breakdowns, sciatica, neurasthenia, etc.

Kidney Spring, medicinal classification, weak calcic sulphated 2 or (−CaS2). This is a moderately mineralized, sodic, muriated, calcic sulphated saline water, possessing diuretic and antilithic properties. It has been found useful in the treatment of disorders of the genito-urinary tract and in sluggish conditions of the alimentary tract.

This splendid spa, located in the heart of the "Black Hills," has been transformed from forest primeval, where hardly more than half a century ago wild beasts roamed and savage aborigines held full sway; and today the environs assume the familiar aspect of *fin de siecle* of civilization. The scenery adjacent to this favored spot is wild, weird and full of natural grandeur, grand canyons, rippling streams and dashing waterfalls; along the Minnekahta and Cheyenne Rivers presenting a group of attractions difficult to excel. The location and situation of this delightful resort, owing to peculiar topographical features, has a mild equable climate, never too hot in summer nor too cold in winter; it is pleasing and delightful. (See also Chapter XV.)

The following springs were once used as resorts:

*Wessington Springs, P. O.*, Wessington Springs, Jerauld County. This is said to be a chalybeate water, sulphuretted. Once popular as a resort. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Culbert Spring, P. O.*, Aberdeen, Brown County.

*Johnson's Well, P. O.*, Milbank, Grant County.

*Minnehaha Springs, P. O.*, Sioux Falls, Minnehaha County.

## TENNESSEE.

Tennessee extends from 35° to 36°41′ north latitude and from 81°45′ to 90° west longitude, and embraces an area of 42,050 square miles, of which 150 square miles are covered by water. The state has an extreme length from east to west of 432 miles and a breadth of 109 miles from north to south. The topographical features of the state are interesting. The easternmost portion is covered by the Unaka or Great Smoky Mountains, a belt of bold ridges with an average elevation of 5000 feet, but a number of peaks rise to 6636 feet. West of the Great Smoky Mountains lies the Tennessee Valley, to the west of which rises the escarpment of the Cumberland Plateau, which occupies the central portion of the state. As its name implies, it forms a rim encircling the Central Basin, a large oval depression lying several hundred feet below the surrounding highlands. Tennessee is remarkable throughout its limits for its extensive forests, and abounds in an abundance of beautiful mountain scenery, especially in the mountain terrains rugged and picturesque. The climate is generally mild and equable and, except in the western lowlands, is healthful

and salubrious. The mean temperature varies slightly in different sections of the state. For January, 3.3° C. (38° F.); for July, 24.8° C. (77° F.); the maximum is 40° C. (104° F.) and the minimum is seldom less than −12.2° C. (11.5° F.).

Tennessee has 117 spring localities, with a total of 311 individual springs, of which 24 have been analyzed and 62 have at various times been used as resorts. The mineral springs of Tennessee are numerous, and many of them of considerable importance. Chalybeate and sulphuretted predominate, but several magnesic waters are found. A large number have been used as resorts and were much frequented fifty years ago, but have since fallen into innocuous desuetude. Many have some reputations at the present time, and are liberally patronized. The following list has been secured from the literature on the subject and from personal correspondence.

### Buena Vista Springs.

*(Davidson County.)*

*Postoffice,* Nashville. *Location,* near central Tennessee; west of Knoxville, 140 miles; northeast of Memphis, 180 miles; northwest of Chattanooga, 180 miles. *Situation,* in the northern section of the city of Nashville, in a beautiful landscaped park of some 20 acres, at an elevation of 650 feet above sea level. The climate is mild, equable and salubrious. *Access,* via the Southern Railway, the Louisville & Nashville Railway and the Chicago, Rock Island & Pacific Railway System. *Hotel,* the Buena Vista Springs Sanitarium is a commodious structure, with modern conveniences. The bathing establishment is modern in construction and equipment. The springs, 8 in number, arise within a radius of some 70 square feet, and embrace a variety of valuable mineral waters, which have been in constant use by the profession for more than a century.

The old analyses have been discarded, and the springs are all being analyzed anew, which are not completed as we go to press. The old analyses show the following, viz:

Black Sulphur Spring is a moderately highly mineralized, calcic, magnesic, sulphated and bicarbonated water, sulphuretted, carrying total solids of about 2665 parts per 1,000,000.

White Sulphur Spring shows a moderately highly mineralized, sodic, muriated, alkaline-saline water, sulphuretted, carrying about 1026 parts per 1,000,000 of total solids.

Red Sulphur Spring is a moderately highly mineralized, sodic, muriated, magnesic and sodic sulphated, saline water, sulphuretted, carbon-dioxated, carrying about 2670 parts per 1,000,000 of total solids.

Lithia Spring is a moderately mineralized, calcic, bicarbonated, sulphated, alkaline water, carbon-dioxated, carrying about 596 parts per 1,000,000 of total solids. Besides there are 4 other springs, viz.:

Freestone, Chalybeate, Limestone and Yellow Sulphur. These waters have been popular with the profession for more than a century.

## Fernville Springs.

(*Williamson County.*)

*Postoffice*, R.F.D. Franklin. *Location*, west of central Tennessee; southwest of Nashville, the capital city, 25 miles; west of Knoxville, 165 miles. *Situation*, in the valley of the South Harpeth River, on the western rim of the Cumberland Plateau, at an elevation of about 1400 feet above sea level. The region is well drained, healthful and salubrious, and the most picturesque section in middle Tennessee. *Access*, via the Nashville, Chattanooga & St. Louis Railway to Bellview Station, thence by motor 12 miles to the springs; via Louisville & Nashville Railway to Franklin, thence by motor 13 miles to the springs. *Hotel*, there are at present a number of cottages and a community kitchen and dining room operated by a club. The owner writes that he is planning a small fireproof resort hostelry and a few cottages sufficient to accommodate 200 guests for next season. There are a number of springs in this area, of which 3 have been analyzed:

FERNVILLE SPRINGS.

| | Parts per 1,000,000. | | |
|---|---|---|---|
| | Analyst, N. T. Lupton. | Analyst, Wilbur A. Nelson. | |
| Hypothetical combinations. | Spring No. 1. | Spring No. 2. | Spring No. 3. |
| Sodium chloride (NaCl) | 151.33 | 14.87 | 22.23 |
| Sodium sulphate ($Na_2SO_4$) | 235.59 | 589.95 | 200.07 |
| Calcium sulphate ($CaSO_4$) | 372.47 | 335.16 | |
| Lithium bicarbonate ($LiHCO_3$) | trace | | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 58.17 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 180.61 | 238.24 | 108.02 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 195.02 | 277.02 | 293.64 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 2.77 | 2.77 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 9.40 | | |
| Silica ($SiO_2$) | 0.85 | 13.68 | 10.26 |
| Total solids | 1145.27 | 1471.69 | 695.16 |

Spring No. 1, medicinal classification, weak alkaline b, weak calcic sulphated 2 or (−Ab, −CaS2). This is a moderately highly mineralized, sodic, calcic, sulphated, muriated, alkaline-saline water, sulphuretted, possessing diuretic, antacid and tonic properties.

Spring No. 2, Vale Spring, medicinal classification, weak alkaline b, weak calcic sulphated 2 or (−Ab, −CaS2). This is a moderately mineralized, sodic and calcic and sulphated and calcic, magnesic, bicarbonated, alkaline-saline water, sulphuretted, possessing diuretic and tonic properties.

Spring No. 3, Mayfield Spring, medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic sodic bicarbonated alkaline-saline water, sulphuretted, possessing diuretic, antacid and tonic properties.

The waters of all 3 springs are sulphuretted and have been used efficaciously in the treatment of squamous skin affections and in disorders of the bowels, where stimulation is needed. The sulphate ions increase the flow of mucus and liquefy intestinal secretions. The water also is useful in disorders of the genito-urinary tract.

## Gailbraith Springs.

### (*Hawkins County.*)

*Postoffice,* Galbraith Springs. *Location,* in northeastern section of the state; west of Kingsport, 40 miles; northeast of Knoxville, 55 miles. *Situation,* in the heart of the Blue Ridge Mountains, surrounded by a magnificent natural forest, covering a broken rough and rugged mountainous country. The springs issue from the crust of the earth in a beautiful glen, 330 feet above the base of Short Mountain, and 1400 feet above sea level, 1 mile from the historic Holston River. A path from the hotel leads to the U. S. Signal Station, sitting atop Short Mountain, which is 1302 feet above the springs and 2702 feet above sea level. From this "look out" many wonderful scenic panoramas of east Tennessee meet the eye on the rim of the horizon. *Access,* via Russelville on the Southern Railway, thence via macadam mountain highways, leading through a beautifully picturesque mountainous region, profusely decorated with wild mountain flowers, whose redolence fills the air with a sweet fragrance, 9 miles to the springs. *Hotel,* there is a very comfortable resort establishment, with modern conveniences. There are 4 springs in this area, all arising within a comparatively small area and all varying in their predominating chemical constituents; we present below analyses of 2 of the more important springs:

GALBRAITH SPRINGS

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, W. A. Noyes.) Spring No. 1. | (Analyst, C. A. Moores.) Epsom Lithia Spring. |
|---|---|---|
| Lithium chloride ($LiCl$) | ... | trace |
| Sodium chloride ($NaCl$) | 1.30 | 25.48 |
| Sodium sulphate ($Na_2SO_4$) | 4.4 | 4.79 |
| Potassium sulphate ($K_2SO_4$) | 2.78 | 82.20 |
| Calcium sulphate ($CaSO_4$) | ... | 487.00 |
| Magnesium sulphate ($MgSO_4$) | ... | 1239.40 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace | |
| Calcium nitrate ($Ca[NO_3]_2$) | trace | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 14.06 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 65.72 | 1033.3 |
| Lithium bicarbonate ($LiHCO_3$) | trace | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 10.73 | |
| Aluminum oxide ($Al_2O_3$) | 0.59 | |
| Silica ($SiO_2$) | 11.67 | 9.59 |
| Total solids | 111.25 | 2881.76 |

Spring No. 1 is a lightly mineralized, calcic, ferruginous bicarbonated alkaline water, possessing diuretic and slight antacid properties and, due to the bicarbonate of iron, it possesses considerable merit as a ferruginous tonic.

Epsom Lithia Spring, medicinal classification, weak alkaline b3 calcic sulphated or (−Ab3, CaS). This is a moderately highly mineralized, magnesic, calcic and potassic sulphated, alkaline-saline water, possessing diuretic, antacid, laxative and tonic properties. This water is of the same class as the celebrated Tate Spring water; the predominating chemical constituents of both waters are quite similar in total percentage of amounts. It is highly endorsed by the local profession in disorders of the bowels and kidneys as a pleasing eliminant of waste products and favoring reparative processes.

## Glenn Springs.

(*Tipton County.*)

*Postoffice,* Atoka. *Location,* in the extreme western portion of the state; only a few miles east of the Mississippi River; north of Memphis, 32 miles; northwest of Atoka, 8 miles. *Situation,* in a deep vale on the eastern border of the Mississippi River Valley, at the foot of Chicasaw Mountain, amid a beautiful picturesque region, with rugged hills to the eastward, presenting a scenic picture of great charm and many attractions. *Access,* via Atoka Station, on the main line of the Illinois Central Railway, thence by motor 8 miles to the springs. *Hotel;* there is a modern structure, new and thoroughly sanitary, commodious and comfortable. The Glenn Springs water, on analysis, shows the following mineralization:

GLENN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. T. Lupton). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 2.74 |
| Potassium sulphate ($K_2SO_4$) | 4.62 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.17 |
| Sodium bicarbonate ($NaHCO_3$) | 43.77 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 196.68 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 255.97 |
| Potassium bicarbonate ($KHCO_3$) | 1.38 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 14.97 |
| Silica ($SiO_2$) | 23.59 |
| Total solids | 543.29 |

Medicinal classification, weak alkaline b or (−Ab). An examination of the analysis shows a moderately mineralized, calcic, magnesic, sodic, bicarbonated alkaline water, possessing antacid, diuretic and tonic properties. The water has been successfully prescribed in kidney and bladder affections and in gastric distress due to acidity. The water is highly endorsed by local physicians in a wide range of diseases.

## Montvale Springs.

(*Blount County.*)

*Postoffice*, Newport. *Location*, eastern Tennessee; south of Knoxville, 25 miles; north of Murphy, N. C., 50 miles; east of Murfreesboro, 140 miles. *Situation*, at the foot of the Chilhowee Mountains, 1300 feet above tide water. The Great Smoky Mountain Range lies to the south and east. *Access*, via the Knoxville & Augusta Railway to Marysville, thence by motor a short distance to the springs; or via the Southern Railway System and connections. *Hotel*, there is a large commodious resort hostelry, with modern conveniences. The climate is delightful; the atmosphere invigorating. The water, on analysis reveals the following mineralization:

MONTVALE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, S. B. Mitchell) |
|---|---|
| Sodium chloride (NaCl) | 33.51 |
| Sodium sulphate ($Na_2SO_4$) | 77.12 |
| Magnesium sulphate ($MgSO_4$) | 205.20 |
| Calcium sulphate ($CaSO_4$) | 1238.21 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 367.32 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 66.44 |
| Aluminum oxide ($Al_2O_3$) | 8.50 |
| Silica ($SiO_2$) | trace |
| Total solids | 1996.30 |

Medicinal classification, weak alkaline b, weak calcic sulphated 4 or (−Ab, −CaS4). This is a moderately mineralized, calcic sulphated and bicarbonated, alkaline-saline water, possessing diuretic, slight aperient and tonic properties. The water is highly endorsed in the treatment of dyspeptic affections, and of use in treating uric-acid conditions, especially those presenting genito-urinary symptoms.

## Oliver Springs.

(*Anderson County.*)

*Postoffice*, Oliver Springs. *Location*, in eastern Tennessee; east of Knoxville, 30 miles; east of Nashville, the capital city, 120 miles; north of Morganton, Ga., 75 miles; south of Winchester, Ky., 125 miles. *Situation*, on the southern slope of the Cumberland Mountains, where the counties of Anderson, Roane and Morgan join their boundary lines, at an elevation of 980 feet above sea level. The climate is pleasing and delightful. *Access*, via the Southern Railway to Oliver Springs Station, thence by motor a short distance to the springs; via Louisville & Nashville Railway, thence 9 miles to the springs. *Hotel*, there is a commodious resort hostelry offering many conveniences and

accommodations. There are 9 springs in this area, of which we present the analyses of the following, which reveal the mineralization:

OLIVER SPRINGS.

(Parts per 1,000,000 (Analyst, University of Kentucky).

| Hypothetical combinations. | White Sulphur Spring. | Chalybeate Spring. | Magnesia Spring. |
|---|---|---|---|
| Potassium chloride (KCl) | ... | 7.6 | |
| Sodium chloride (NaCl) | 6.6 | 7.9 | 3.3 |
| Potassium sulphate ($K_2SO_4$) | 12.6 | ... | 10.7 |
| Sodium sulphate ($Na_2SO_4$) | 46.7 | | |
| Magnesium sulphate ($MgSO_4$) | 299.6 | | |
| Calcium sulphate ($CaSO_4$) | 728.9 | 4.9 | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 14.1 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 51.2 | 13.9 | 60.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 182.3 | 6.3 | 126.4 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 15.5 | |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 5.2 | ... | 2.5 |
| Silica ($SiO_2$) | 16.2 | 5.7 | 12.8 |
| Total solids | 1349.3 | 61.8 | 230.4 |
| Gas: | | | |
| Hydrogen sulphide | 1.1 | 0.1 | |

White Sulphur Spring, medicinal classification, weak calcic sulphated 3 or (−CaS3). This is a moderately mineralized, sodic, calcic, magnesic, sulphated and bicarbonated alkaline-saline water, sulphuretted, possessing diuretic, antacid, slight laxative and slight tonic properties.

Chalybeate Springs is a slightly mineralized, ferric, magnesic, bicarbonated, alkaline water, possessing tonic and alterative properties. This water is a valuable iron tonic, carrying 15.5 mg. of the bicarbonate of iron to the liter of water.

Magnesic Spring is a lightly mineralized sodic, calcic, magnesic, bicarbonated, alkaline water, possessing slight diuretic antacid and tonic properties. This group of springs has three types of waters indicated in a wide range of diseased conditions and, no doubt, when better known will become quite popular.

The hotel has been destroyed by fire and is not yet replaced. The building site is ideal, affording a splendid view and easy access to the mineral waters.

## Rhea Springs.

(*Rhea County.*)

*Postoffice,* Rhea Springs. *Location,* in eastern Tennessee; southwest of Knoxville, 50 miles; southeast of Nashville, the capital city, 100 miles; northeast of Chattanooga, 50 miles; north of Dayton, the county seat, 20 miles. *Situation,* east of the Waldens Ridge, lying in a beautiful valley drained by the famous Piney River, skirting the

foothills of the western slope of the Blue Ridge Mountains, at an elevation of 1200 feet above sea level. *Access*, via the connections with the Southern Railway to Spring City, thence only a short distance, 2 miles by motor to the springs; via motor cars, over the great national highways which traverse this section. *Hotel*, the first hotel, erected here in 1856, was destroyed by fire in 1921, and the present structure was erected of great logs from the adjoining forest, while the furnishings and fittings are thoroughly modern in all appointments and conveniences, private baths and running hot and cold water. The analysis below shows the mineralization:

RHEA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. Wm. Baker). |
|---|---|
| Sodum chloride (NaCl) | 23.0 |
| Sodium sulphate ($Na_2SO_4$) | 513.0 |
| Magnesium sulphate ($MgSO_4$) | 234.0 |
| Calcium sulphate ($CaSO_4$) | 600.0 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 616.0 |
| Sodium silicate ($Na_2SiO_3$) | 91.0 |
| Total solids | 2077.0 |

Gas: Carbon dioxide (free), large amount.

Medicinal classification, weak sulphated 2, weak ferruginous 1.5 or (−S2, −Fe 1.5). The analysis shows this to be a moderately highly mineralized, sodic, magnesic and calcic, sulphated and ferruginous bicarbonated, alkaline-saline water, carbon-dioxated, possessing diuretic, laxative and tonic properties. This water should be of value in the treatment of catarrhal conditions of the gastro-intestinal tract and in chronic hepatic disorders. From the high ferruginous content, it should also be of decided value in all run-down conditions, where an iron tonic is indicated, such as anemia and chlorosis, especially in young girls just budding into womanhood, who need an iron tonic.

## Red Boiling Springs.

### (*Macon County.*)

*Postoffice*, Red Boiling Springs. *Location*, in the middle northern section of the state; northeast of Nashville, the capital city, 50 miles; northwest of Knoxville, 100 miles. *Situation*, the springs nestle among the foothills of the Cumberland Mountains, at an elevation of 1200 feet above sea level. *Access*, via the Louisville & Nashville Railway to Hartsville, thence by motor to the springs; via Tennessee Central Railway to Carthage, thence by motor a short distance to the springs. or by the Bus Line operated from Nashville to the springs, or via motor cars over the great national highways which traverse this section. *Hotels*, there are several good hotels. Besides these there

are a number of cottages and private homes, where accommodations can be had. The bathing establishment connected with the hotel is modern in construction and equipment, and fitted with every known apparatus for the successful application of the latest knowledge in hydrotherapy and balneotherapy, all under the supervision of a competent physician with a trained corps of assistants, with separate departments for men and women. There are several springs in the area, and we present herewith the analyses of some of the more important springs.

RED BOILING SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. Analyst, L. Pitkin. Little Red Sulphur Spring. | Red Sulphur Spring. | (Analyst, J. T. Anderson). Black Sulphur Spring. |
|---|---|---|---|
| Sodium chloride (NaCl) | 55.24 | 652.95 | 183.48 |
| Calcium chloride ($CaCl_2$) | ... | 19.87 | |
| Potassium sulphate ($K_2SO_4$) | 7.01 | | |
| Sodium sulphate ($Na_2SO_4$) | 16.07 | | |
| Calcium sulphate ($CaSO_4$) | 139.00 | 886.21 | 262.66 |
| Magnesium sulphate ($MgSO_4$) | ... | 279.95 | 136.29 |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | 28.35 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 77.85 | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 53.75 | 559.87 | 255.71 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.56 | | |
| Ferric oxide ($Fe_2O_3$) | ... | 28.21 | 1.36 |
| Aluminum oxide ($Al_2O_3$) | ... | 8.25 | 2.05 |
| Silica ($SiO_2$) | 12.69 | 19.93 | 39.50 |
| Total solids | 364.17 | 2455.24 | 909.40 |
| Temperature, °C. | 12.2 | ... | 14.0 |
| Gases: | | | |
| Hydrogen sulphide, cc. per liter | 13.8 | 11.3 | 16.2 |

Little Red Sulphur Spring, medicinal classification, weak total mineralization or (−T), sulphuretted. This is a lightly mineralized, calcic and sodic sulphated saline water, sulphuretted.

Red Sulphur Spring, medicinal classification, weak alkaline b, weak saline 2, weak calcic sulphated 3, very weak ferruginous or (−Ab, −Cl 2, −CaS3, −−Fe), sulphuretted. This is a moderately highly mineralized, calcic and magnesic sulphated saline (ferruginous, aluminic) water, sulphuretted.

Black Sulphur Spring, medicinal classification, weak calcic sulphated or (−CaS), sulphuretted. This is a moderately mineralized, calcic and magnesic sulphated and sodic muriated saline water, sulphuretted.

These waters are highly endorsed by the profession throughout this and adjoining states. The waters from the two red springs are efficacious in the treatment of bladder and kidney affections. The Black Water Spring, so-called from a black sediment deposited around the springs, is a valuable water for the relief of gastro-intestinal disorders.

The iron content in Red Sulphur Spring gives to this water valuable tonic properties in all run-down conditions, anemia and chlorosis, etc.

### Sunrise Mineral Springs.

*(Cheatham County.)*

*Postoffice*, Ashland City. *Location*, in northern Tennessee; northwest of Nashville, the capital city, 25 miles; south of Elkton, Ky., 25 miles; east of Union City, 100 miles. *Situation*, in the Cumberland Valley, on the north side of the Cumberland River, at an elevation of 1250 feet above sea level. *Access*, via the Southern Railway System to Ashland City, thence by motor a short distance to the springs. *Hotel*, no accommodations at the springs but good hostelry in Ashland City. The analysis below shows the mineralization:

SUNRISE MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Wahl-Henius Institute.) |
|---|---|
| Sodium chloride ($NaCl$) | 6,963.0 |
| Sodium sulphate ($Na_2SO_4$) | 1,166.0 |
| Calcium sulphate ($CaSO_4$) | 2,198.0 |
| Magnesium sulphate ($MgSO_4$) | 1,642.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 162.0 |
| Ferrous sulphate ($FeSO_4$) | 38.0 |
| Silica ($SiO_2$) | 1.6 |
| Total solids | 12,170.6 |

Medicinal classification, saline 3, sulphated 3 or (Cl3, S3). This is a highly mineralized, sodic, muriated and sulphated saline (ferruginous) water, possessing diuretic and purgative properties. This water should be of value in the treatment of sluggish bowel action and in disorders of the liver, where stimulation is needed. It is recommended to increase the flow of gastric juice and of bile, improve the appetite and the excretion of uric acid.

### Tate Springs.

*(Grainger County.)*

*Postoffice*, Tate Spring. *Location*, in the northeast corner of the state, in the heart of the Cumberland Mountains; northeast of Knoxville, 40 miles; west of Johnson City, 70 miles; northwest of Asheville, N. C., about 85 miles. *Situation*, in a beautiful mountain-environed valley, at the foot of the Clinch Mountain, 1480 feet elevation; some of the peaks of Clinch Mountain reach an altitude of 3000 feet above sea level. *Access*, via Tate Spring Depot, on the Knoxville & Bristol Railway, thence 1½ miles by motor to the springs. *Hotel*, there is a good hotel, with all modern conveniences, besides a cottage hotel and

a number of individual bungalow cottages, which furnish additional accommodations. Tate Spring has been conducted as a resort for the past fifty years, open, much of the time, all year round. The analysis below gives the mineralization:

TATE SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, T. S. Antisell). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.03 |
| Lithium chloride (LiCl) | 0.60 |
| Potassium chloride (KCl) | 15.70 |
| Sodium chloride (NaCl) | 2.00 |
| Sodium sulphate ($Na_2SO_4$) | 75.60 |
| Magnesium sulphate ($MgSO_4$) | 598.50 |
| Calcium sulphate ($CaSO_4$) | 1319.50 |
| Sodium nitrate ($NaNO_3$) | 0.28 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 345.80 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 4.10 |
| Calcium silicate ($CaSiO_3$) | 4.30 |
| Silica ($SiO_2$) | 19.60 |
| Total solids | 2385.41 |

Medicinal classification, calcic sulphated or (CaS). This is a moderately highly mineralized, calcic, magnesic, sulphated saline water, flowing at the rate of 3240 gallons daily, and is referred to as the Carlsbad of America. The analysis shows the water to be a saline purgative water, with tonic and alterative properties. It is highly endorsed by the profession in gastro-intestinal disturbances, in hepatic disorders and in functional disturbances of the nervous system induced by overwork and business perplexities, in cases of neurasthenia and insomnia and in chronic metallic poisoning. The main hotel is surrounded by a beautiful rolling 100-acre park, beautified with gorgeous "blue-grass" lawns, choice flowers and perennial shrubbery, among which meandering graveled walks and magnificent old shade trees lend to the enchantment. The waters are bottled and shipped commercially all over the country.

## Upper Red Boiling Springs.

(*Macon County.*)

*Postoffice,* Boiling Springs. *Location,* in midnorthern Tennessee; northeast of Nashville, the capital city, 52 miles; south of Scottsville, Ky., 35 miles. *Situation,* in the foothills of the Cumberland Mountains, at an elevation of about 1200 feet above sea level. *Access,* via the Louisville & Nashville Railway to Hartsville, thence by motor a short distance to the springs. This resort was formerly known as Whitney's Springs. *Hotel,* there is a typical resort hostelry for the accommodations of guests. The Red Spring emits a large amount of gas, which to an onlooker appears to be "boiling up." The escaping gas leaves behind a sediment, which deposits on the sides of the spring,

on rocks, etc., and imparts a bright red tinge to the water. The analysis shows the following mineralization:

UPPER RED-BOILING SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. M. Safford). |
|---|---|
| Potassium chloride (KCl) | 7.52 |
| Sodium chloride (NaCl) | 750.17 |
| Calcium sulphate ($CaSO_4$) | 532.83 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 2.56 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 149.28 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 194.74 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.77 |
| Silica ($SiO_2$) | 8.03 |
| Total solids | 1647.90 |

Medicinal classification, weak alkaline b, weak saline 2, weak calcic sulphated or (−Ab, −Cl2, −CaS). This is a moderately mineralized, sodic, calcic, muriated, sulphated and bicarbonated alkaline-saline water, possessing diuretic, antacid, antilithic and tonic properties. The waters are highly recommended in renal and vesical disorders and especially those due to the uric-acid diathesis. The water is claimed to possess solvent action in renal and vesical calculi.

## Wayland Springs.

(*Lawrence County.*)

*Postoffice,* Iron City. *Location,* near the center of the southern boundary of the state and only about 10 miles from the northern boundary line of the state of Alabama; southwest of Nashville, the capital city, 80 miles; east of Memphis, 155 miles. *Situation,* in a beautiful rolling section of country high up in the hills. The surroundings of the springs are very attractive; the scenic views pleasing and impressive. *Access,* via Southern Railway and the national highways, which are a delight for motorists. *Hotel,* accommodations primitive and crude, but has been receiving guests for the past seventy-five years. The waters on analysis shows the following mineralization:

WAYLAND SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. N. O. Curry). |
|---|---|
| Sodium chloride (NaCl) | 630.00 |
| Sodium iodide (NaI) | 3.07 |
| Sodium bromide (NaBr) | trace |
| Iodine (I) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 322.77 |
| Magnesium bicarbonate ($MgHCO_3]_2$) | 110.93 |
| Ferric oxide ($Fe_2O_3$) | 28.70 |
| Silica ($SiO_2$) | 22.65 |
| Total solids | 1118.12 |

Medicinal classification, weak alkaline a, weak saline 2, very weak ferruginous or (−Aa, −Cl 2, −−Fe). This is a moderately mineralized, sodic, muriated and bicarbonated alkaline-saline (ferruginous) water, carbon-dioxated. This water possesses diuretic, tonic, alterative and reconstructive properties. It has been used with success in glandular, cutaneous and enfeebled states of the system. It is a highly efficient chalybeate tonic and useful in anemia and chlorosis and in conditions where the hemoglobin content of the blood is below normal.

### Whittle Springs.

(*Knox County.*)

*Postoffice*, Knoxville. *Location*, in eastern Tennessee; east of Nashville, the capital city, 150 miles; northeast of Chattanooga, 90 miles; south of Lexington, Ky., 145 miles. *Situation*, within the city limits of Knoxville, among the outlying spurs of the Blue Ridge Mountains, at an elevation of 1400 feet above sea level. *Access*, via the Louisville & Nashville and Southern Railways or via motor over the Dixie and the national highways. *Hotel*, there is a magnificent fireproof structure, with private bath and showers; every known modern convenience. There is ample provision for bathing, an out-door swimming pool, 80 by 180 feet and from a few inches to 10 feet in depth. The water, on analysis, shows the following mineralization:

WHITTLE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Geological Survey). |
|---|---|
| Lithium chloride ($LiCl$) | 0.72 |
| Potassium chloride ($KCl$) | 17.70 |
| Sodium chloride ($NaCl$) | 6.10 |
| Sodium sulphate ($Na_2SO_4$) | 44.80 |
| Magnesium sulphate ($MgSO_4$) | 549.20 |
| Sodium nitrate ($NaNO_3$) | 7.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 20.67 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 641.82 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.80 |
| Silica ($SiO_2$) | 13.60 |
| Total solids | 1302.41 |

Medicinal classification, weak alkaline b2, weak sulphated or (−Ab2. −S). This is a moderately mineralized, calcic, bicarbonated and magnesic sulphated alkaline-saline water, possessing diuretic, antacid and laxative properties. The sulphate ions are present in solution in sufficient quantity to stimulate secretions of the intestinal tract and to liquefy same, resulting in bowel action. The Whittle Spring water has become well and favorably known for its curative virtues, especially in disorders of the gastro-intestinal tract, hepatic and renal disorders, gout and the rheumatic diathesis. The waters are bottled and shipped commercially.

The following springs were once used as resorts:

*Austin's Spring, P. O.*, Johnson City, Washington County. No definite information nor satisfactory analysis available.

*Avoca Springs, P. O.*, Bristol, Sullivan County. Small hotel; located in a mountainous section, 1650 feet above sea level. There are 3 springs in this area. At one time this place enjoyed quite a local reputation, but no definite information nor satisfactory analysis available.

*Dixie Springs, P. O.*, Knoxville, Knox County. Located on the northern slope of the Blue Ridge Mountains, at an elevation of about 1000 feet above sea level, overlooking the beautiful Tennessee Valley. No definite information nor satisfactory analysis available.

*Dixon Springs, P. O.*, Perryville, Decatur County. The springs are located in the Tennessee Valley, but for want of attention they have been allowed to languish and pass into innocuous desuetude. No definite information nor satisfactory analysis available.

*Glen-Alpine Springs, P. O.*, Newport, Cocke County. Location in east Tennessee, about 3000 feet above sea level. Once an attractive summer resort. No definite information nor satisfactory analysis available.

*Horn's Mineral Springs, P. O.*, Horn's Spring, Wilson County. Location, 30 miles northeast of Nashville. There are 8 springs in this area. Some of the waters are similar to that of the Crab Orchard Springs in Kentucky. No definite information nor satisfactory analysis available.

*Howard Springs, P. O.*, Crossville, Cumberland County. Located at an elevation of 1900 feet above sea level. There are 4 springs in the area, the largest flowing at the rate of 600 gallons per hour. The water is said to be strongly chalybeate, containing sulphur and magnesia. No definite information nor satisfactory analysis available.

*Line Spring, P. O.*, Line Spring, Sevier County. Located 30 miles west of Knoxville, at an elevation of 2600 feet above sea level. The waters are said to be of a chalybeate character. No definite information nor satisfactory analysis available.

*South Saratoga Springs, P. O.*, Pikeville, Bledsoe County. Located on a plateau of the Cumberland Mountains, 1800 feet above sea level, and 10 miles west of Pikeville. The waters are said to be efficacious in liver and kidney disorders. No definite information nor satisfactory analysis available.

*Wright's Epsom Lithia Well, P. O.*, Moorseburg, Hawkins County. Located 5 miles from Galbraith Springs. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Faulkner Springs, P. O.*, McMinnville, Warren County.

*Bush Mineral Wells, P. O.*, Nashville, Davidson County.

*Beersheba Springs, P. O.*, Beersheba Springs, Grundy County.

*Bright Springs, P. O.*, Ashland City, Cheatham County.

*Allegheny Springs (Chalybeate and Sulphur), P. O.*, Mint R.F.D.

*Bon Aqua Springs, P. O.*, Bon Aqua, Tenn., Hickman County.
*Aqua Sanitas Springs, P. O.*, Franklin, Williamson County.
*Castillian Springs, P. O.*, Castillian Springs, Sumner County.
*Dupont Springs, P. O.*, Sevierville, R.F.D., Sevier County.
*Darnell Well, P. O.*, Clarkeville, Montgomery County.
*Elkmont Springs, P. O.*, Prospect Station, R.F.D., Giles County.
*Eagle Bluff Springs, P. O.*, Jacksboro, Campbell County.
*Gibson Wells, P. O.*, Humboldt, Gibson County.
*Hamilton Springs, P. O.*, Lebanon, Wilson County.
*Hinson Springs, P. O.*, Hinson Springs.
*Hygeia Springs, P. O.*, Greenbrier, R.F.D., Robertson County.
*Lea Spring, P. O.*, Lea Springs, Grainger County.
*Melrose Springs, P. O.*, Maryville.
*Nebo Springs, P. O.*, Walland, Blount County.
*Pioneer Springs, P. O.*, Nashville, Davidson County.
*Pylant Springs, P. O.*, Tullahoma, R.F.D., Coffee County.
*Red Sulphur Springs, P. O.*, Red Sulphur Springs, Hardin County.
*Robinson Springs, P. O.*, Chalybeate, R.F.D., Van Buren County.
*Sulphur Springs, P. O.*, Ashland City, Cheatham County.
*Unaca Springs, P. O.*, Unaca Springs, Unaca County.
*Wildwood Springs, P. O.*, Walland, Blount County.

## TEXAS.

Texas extends from 25°51′ to 36°30′ north latitude and from 93°31′ to 106°43′ west longitude, and comprises an area of 265,780 square miles, of which 3490 square miles are covered by water. The greatest length from north to south is about 800 miles and the greatest distance from east to west is about 750 miles. It is the largest state in the Union, and nearly one-third greater than the whole German Empire. The coastal plain rises gradually from the sea level and extends inward about 150 miles, where it has an elevation of 500 feet. West of the coastal plain extends a belt of rolling country known as the Black Prairie about 100 miles wide in the north and south, but very narrow in the middle portion. In the northwest is a very broad belt of country known as Central Denuded Region, which rises to an elevation of 2000 feet in the west. This region is a very rugged area extending southward to the Rio Grande Valley. That portion of the state lying beyond the Pecoe Valley is a rugged mountainous country, in which are many tall peaks overlooking arid valleys. The tallest peak is Baldy Peak, 8282 feet in elevation. A prominent climatological feature observed in the state is the occurrence during the fall and winter months of high winds called "northers," which sweep the state and far out into the Gulf of Mexico, disturbing navigation. The mean annual temperature is 13.3° C. (56° F.); in the far north, 18.9° C. (66.72° F.); in the far south, 24.1° C. (75° F.); on the coast the

temperature never reaches zero, but in the extreme northwest it falls several degrees below zero.

Texas is credited with having 105 spring localities and 472 individual springs, of which 13 have been analyzed and 25 at some time used as resorts. Walton gives 3 spring localities, Crook 10 and Peale 13. Sulphuretted waters predominate, but saline and chalybeate waters are plentiful. The following list is made up from personal correspondence with physicians and spring owners. Eight spring localities are reported selling waters during the year 1923.

## Crazy Mineral Wells.

### (*Palo Pinto County.*)

*Postoffice*, Mineral Wells. *Location*, in northern central Texas; north of Austin, the capital city, 175 miles; west of Dallas, 80 miles; south of Lawton, Okla., 110 miles. *Situation*, in the heart of the Palo Pinto Mountains, in a beautiful valley, at an elevation of about 1500 feet above sea level. *Access*, via the Missouri Pacific Railway System and the Texas Pacific & Santa Fe Railway. *Hotel*, there is a four-story brick structure, with modern conveniences. The climate is mild, equable and salubrious. The wells, about 50 or more, are in the vicinity, of which we present the analysis of 4, showing the mineralization:

CRAZY MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. T. Reade). | | | |
|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. |
| Ammonium chloride ($NH_4Cl$) | trace | trace | trace | trace |
| Potassium chloride (KCl) | 97.66 | 262.07 | 66.84 | 88.85 |
| Sodium chloride (NaCl) | 472.74 | 986.55 | 190.27 | 414.02 |
| Sodium sulphate ($Na_2SO_4$) | 1015.20 | 1887.08 | 3326.76 | 4573.32 |
| Magnesium sulphate ($MgSO_4$) | 682.00 | 579.55 | 752.00 | 123.33 |
| Sodium nitrate ($NaNO_3$) | 57.73 | 349.43 | 3.59 | 4.98 |
| Sodium bicarbonate ($NaHCO_3$) | 20.69 | 35.85 | 89.17 | 66.29 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 164.76 | 322.42 | 10.87 | 223.08 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 620.65 | 848.22 | 599.93 | 329.08 |
| Ferric oxide and alumina ($Fe_2O_3$, $AlO_3$) | 7.25 | 81.74 | 58.84 | 3.98 |
| Silica ($SiO_2$) | 9.94 | 22.93 | 22.93 | 19.93 |
| Total solids | 3148.62 | 5375.84 | 5121.20 | 5846.86 |

Spring No. 1, medicinal classification, weak alkaline b2, weak saline, weak sulphated 4 or (−Ab2, −Cl, −S4).

Spring No. 2, medicinal classification, weak alkaline b3, weak saline 3, sulphated or (−Ab3, −Cl 3, S).

Spring No. 3, medicinal classification, weak alkaline b2, sulphated 2 or (−Ab2, S2).

Spring No. 4, medicinal classification, weak alkaline b2, weak saline, sulphated 2 or (−Ab2, −Cl, S2).

The waters of these wells are so similar in the percentage of their predominating chemical constituents and amount of total solids that we will class them together as moderately highly mineralized, sodic, muriated, sulphated, bicarbonated, nitrated alkaline-saline water, possessing diuretic, antacid, laxative and tonic properties. These waters are used in the treatment of gastro-intestinal disorders, particularly constipation, autointoxication, stasis, etc. In sluggish hepatic action this water stimulates the liver and gall ducts.

## Overall Mineral Springs.

*(Robertson County.)*

*Postoffice*, Franklin. *Location*, slightly east of central Texas; northeast of Austin, the capital city, 95 miles; northwest of Houston, 110 miles. *Situation*, east of the Brazos River, in an undulating section of country, surrounded by fertile farms and vast prairies; the area surrounding the wells has an elevation of about 900 feet above sea level. *Access*, via the International & Great Northern Railway to Franklin Station, thence a short walking distance to the wells. *Hotel*, a cyclone a few years ago unroofed the hotel and other buildings, but at the present time new and modern buildings are under construction. The wells, 2 in number, on analyses, show the following mineralization:

OVERALL MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Edgar Everhardt). Well No. 1. | Well No. 2. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | trace | trace |
| Sodium chloride ($NaCl$) | 166.22 | 154.89 |
| Potassium sulphate ($K_2SO_4$) | 12.86 | 43.80 |
| Sodium sulphate ($Na_2SO_4$) | 121.63 | 241.55 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 1398.04 | 85.52 |
| Ammonium sulphate ($[NH_4]_2SO_4$) | trace | |
| Magesium sulphate ($MgSO_4$) | 223.49 | 342.75 |
| Calcium sulphate ($CaSO_4$) | 358.01 | 634.70 |
| Ferrous sulphate ($FeSO_4$) | 1299.53 | 2479.35 |
| Silica ($SiO_2$) | 34.92 | 38.39 |
| Total solids | 3614.70 | 4020.95 |

Well No. 1, medicinal classification, acid aluminum and ferrous sulphated 1.7, weak ferruginous 4 or (AcAlFeS 1.7, −Fe4). This is a moderately highly mineralized, aluminic, ferric, sulphated, acid water, possessing laxative, astringent and tonic properties.

Well No. 2, medicinal classification, acid ferrous sulphated 1.4, ferruginous 1.5 or (AcFeS 1.4, Fe 1.5). This is a moderately highly mineralized, ferric, sulphated, acid (potassic) water, possessing similar therapeutic properties to Well No. 1.

The medical profession of Franklin and surrounding territory highly endorse these waters in a variety of chronic diseases, where an astringent tonic is indicated, chronic diarrhea and dysentery, colitis, prostatitis, etc. It has been used with success in the treatment of scrofulosis, chronic inflammations of the skin, etc. It is indicated as a gargle in tonsillitis, laryngitis, etc.

## Red Mineral Springs.

### (*Titus County.*)

*Postoffice,* Mount Pleasant. *Location,* in northeastern Texas; east of Dallas, 100 miles; north of Houston, 240 miles. *Situation,* in a rolling, hilly district, south of Sulphur Creek, at an elevation of about 600 feet above sea level. *Access,* via the Missouri Pacific Railway System connections. *Hotel,* no definite information as to the class of accommodations.

RED MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, P. S. Tilson). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 1566.58 |
| Magnesium chloride ($MgCl_2$) | 388.55 |
| Calcium chloride ($CaCl_2$) | 345.07 |
| Potassium sulphate ($K_2SO_4$) | trace |
| Sodium sulphate ($Na_2SO_4$) | 1544.04 |
| Magnesium sulphate ($MgSO_4$) | 1020.04 |
| Calcium sulphate ($CaSO_4$) | 1374.05 |
| Potassium bicarbonate ($KHCO_3$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 1256.17 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 290.87 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 346.27 |
| Silica ($SiO_2$) | 5.96 |
| Total solids | 8137.60 |

Medicinal classification, alkaline ab, saline, sulphated 2 or (Aab, Cl, S2). The analysis shows this to be a moderately highly mineralized, sodic, calcic, magnesic, muriated, sulphated, bicarbonated, saline water, carbon-dioxated, possessing diuretic and purgative properties. The sulphate radicles in solution in this water will stimulate the secretion of bile, increase the flow of mucus in the intestinal tract and liquefy the secretions. The bicarbonate radicles will neutralize gastric activity, improve the digestion and aid metabolism. The water is bottled and shipped.

## Sutherland Springs.

### (*Wilson County.*)

*Postoffice,* Sutherland Springs. *Location,* in southern Texas; west of Houston, 150 miles; south of Fort Worth, 250 miles; north of Brownville, 225 miles. *Situation,* this resort is pleasantly situated on the

Rio Cibolo, at an elevation of 400 feet above sea level, in a prairie region, gently undulating, presenting pleasing scenic views, tranquil in character, restful and serene. The climate of this region is mild, equable and salubrious. *Access*, via the San Antonio Division of the Gulf Highway and San Antonio Railway to San Antonio and thence via the Gulf Highway & San Antonio Railway to the springs; also via motor cars over the Glacier to Gulf Highway, at present under construction, which will be a pleasure to motorists. *Hotel*, the Hotel Sutherland is a large commmodious resort hostelry, with modern conveniences. The large concrete swimming pool is an attraction to the guests, many of whom bathe daily in the sulphur waters all the year round; the weather is so mild that is is rarely cold enough to interfere with this pleasant pastime. There is a very large number of springs and wells in this area. The analyses below of the more important of the springs and wells show the variety in these natural medicinal agents, and give the chemical constituents of each, showing in detail the mineralization:

SUTHERLAND SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. P. Randolph, Jr.). | | | | |
|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 3. | Spring No. 4. | Spring No. 5. | Spring No. 6. |
| Potassium chloride (KCl) | 11.10 | 26.5 | 25.7 | 31.3 | 34.5 |
| Sodium chloride (NaCl) | 74.40 | 93.1 | 54.1 | 57.9 | 43.9 |
| Sodium sulphate ($Na_2SO_4$) | 70.10 | 32.7 | 40.1 | 41.6 | 72.2 |
| Magnesium sulphate ($MgSO_4$) | ... | 7.4 | 31.6 | 55.9 | 67.7 |
| Calcium sulphate ($CaSO_4$) | ... | 59.5 | 157.6 | 204.1 | 257.0 |
| Ferrous sulphate ($FeSO_4$) | ... | ... | 44.3 | 73.0 | 31.0 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | ... | 17.2 | 18.2 |
| Sodium bicarbonate ($NaHCO_3$) | 600.95 | | | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 10.80 | | | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 37.60 | 12.1 | | | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.20 | 28.3 | | | |
| Ferric oxide ($Fe_2O_3$) | ... | ... | 21.9 | | |
| Aluminum oxide ($Al_2O_3$) | ... | 7.0 | 6.4 | 0.4 | |
| Silica ($SiO_2$) | 17.30 | 44.1 | 69.4 | 83.4 | 90.2 |
| Total solids | 825.45 | 310.7 | 450.4 | 564.8 | 614.7 |
| Gases, cc. per liter, at 0° C., and 760 mm. pressure: | | | | | |
| Carbon dioxide (free) | none | 18.1 | 15.7 | 7.4 | 7.3 |
| Carbon dioxide from bicarbonates, evaporated to dryness | 84.9 | 5.6 | | | |

Spring No. 1, medicinal classification, weak alkaline a2 or (−Aa2). This is a moderately mineralized, sodic, bicarbonated, alkaline water, possessing diuretic, antacid and tonic properties.

Spring No. 3 is a lightly mineralized, sodic, calcic, muriated and sulphated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid and tonic properties, as it carries a liberal percentage of the bicarbonate of iron, which is easily assimilated.

Spring No. 4, medicinal classification, very weak ferruginous or (− −Fe). This is a moderately mineralized, calcic sulphated and muriated saline (ferruginous) water, sulphuretted, possessing diuretic, antacid and slight aperient properties.

Spring No. 5, medicinal classification, very weak ferruginous or (− −Fe). This is a moderately mineralized, sodic, calcic, ferruginous, sulphated, acid (silicious) water, sulphuretted, possessing diuretic, tonic, styptic and slight aperient properties.

Spring No. 6, medicinal classification, weak calcic sulphated or (−CaS). This is a moderately mineralized, sodic, calcic, ferruginous, sulphated, saline (aluminic) water, sulphuretted, similar in its therapeutic properties to Spring No. 5; the predominating chemical constituents are very similar in percentage composition. Their action will increase the hemoglobin content of the blood.

SUTHERLAND SPRINGS.—*Continued.*

| Hypothetical combinations. | Parts per 1,000,000. | | | | |
|---|---|---|---|---|---|
| | Analyst, C. P. Randolph. | | Analyst, John P. Rote, M.D. | | Analyst, F. H. McDougal. |
| | Spring No. 7. | Spring No. 8. | Spring No. 9. | Hume Sour Well. | Scott's Laxatone Water. |
| Potassium chloride (KCl) | 14.9 | 40.6 | 23.2 | 138.5 | 58.2 |
| Sodium chloride (NaCl) | 72.4 | 141.4 | 95.3 | 368.9 | 53.8 |
| Sodium sulphate ($Na_2SO_4$) | 25.8 | 32.0 | 34.1 | 49.3 | 149.1 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | 61.2 | 232.4 | 95.1 |
| Potassium sulphate ($K_2SO_4$) | ... | ... | ... | 29.2 | |
| Calcium sulphate ($CaSO_4$) | ... | ... | 19.7 | 335.9 | 170.0 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | ... | 59.0 | 109.4 |
| Ferrous sulphate ($Fe_2SO_4$) | ... | ... | ... | 507.5 | 478.0 |
| Sodium bicarbonate ($NaHCO_3$) | 79.9 | 861.7 | | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 14.4 | | | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 202.1 | 76.4 | | | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 9.5 | 3.2 | 25.0 | | |
| Aluminum oxide ($Al_2O_3$) | ... | ... | 16.5 | | |
| Silica ($SiO_2$) | 22.7 | 18.5 | 6.8 | 93.3 | 138.5 |
| Total solids | 441.7 | 1173.8 | 281.8 | 1814.0 | 1252.1 |
| Gases, cc. per liter at 0° C. and 760 mm. pressure: | | | | | |
| Carbon dioxide (free) | 11.0 | 5.8 | none | none | none |
| Carbon dioxide from bicarbonates evaporated to dryness | 4.4 | 133.4 | none | none | none |

Spring No. 7, medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, sodic and calcic, bicarbonated, alkaline-saline water. It is similar to Springs Nos. 1 and 8, and possesses diuretic, antacid and tonic properties, and has a soothing effect upon the mucous membranes of the gastro-intestinal tract and the genito-urinary system.

Spring No. 8, medicinal classification, weak alkaline a2 or (−Aa2). This is a moderately mineralized, sodic, bicarbonated and muriated alkaline-saline water. The water from this spring is very similar to that of Spring No. 1, possessing diuretic, antacid and slight tonic properties. It has been used with success in the treatment of rheumatism, gout and gastric disturbances due to hyperacidity.

Spring No. 9 is a lightly mineralized, sodic, magnesic, muriated and sulphated saline (ferruginous )water, sulphuretted, possessing laxative and tonic properties, and is especially valuable in the treatment of catarrhal diseases of the gastro-intestinal and biliary tracts.

Hume Sour Well, medicinal classification, weak acid, ferrous sulphated 1.6, weak saline, weak calcic sulphated, weak ferruginous 1.5 or (−Ac, FeS 1.6, −Cl, −CaS, −Fe 1.5). This is a moderately mineralized, ferruginous, calcic and magnesic, sulphated (aluminic) acid water, sulphuretted, possessing tonic properties, stimulating the hemoglobin content of the circulating fluid, the secretion of bile and pancreatic juice and the gastric and intestinal fluids. Its high ferruginous content makes it a valuable hematinic, and it should be efficient in all nutritional disorders, especially those of constitutional origin.

Scott's Laxatone Water, medicinal classification, weak acid aluminic ferrous sulphated 1.7, weak calcic sulphated, weak ferruginous 1.4 or (−AcAl FeS 1.7, −CaS, −Fe 1.4). This is a moderately mineralized, ferruginous, calcic and sodic sulphated, acid (aluminic) water, sulphuretted. The acidity of this water increases on exposure to the air. It possesses tonic styptic and alterative properties. This water acts by stimulating the mucous membranes of the intestinal tract, liquefying the mucus and aids in the evacuation of the intestinal contents. Its use stimulates the liver and gall ducts to increased action.

### Tioga Mineral Wells.

*(Grayson County.)*

*Postoffice*, Tioga. *Location*, in northern Texas; south of Ardmore, Okla., 40 miles; west of Texarcana, 160 miles; north of Dallas, 60 miles; east of Gainsville, 40 miles. *Situation*, south of the Red River Valley, in a rolling region of country, at an elevation of about 800 feet above sea level. *Access*, via the Chicago, Rock Island & Pacific Railway System. *Hotel*, no reliable information available as to class of accommodations. This well is called the Well of Life (No. 1), and on analysis shows the following mineralization:

TIOGA MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, F. B. Porter). |
|---|---|
| Calcium chloride ($CaCl_2$) | 1596.3 |
| Sodium sulphate ($Na_2SO_4$) | 973.8 |
| Magnesium sulphate ($MgSO_4$) | 973.8 |
| Calcium sulphate ($CaSO_4$) | 4.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 285.0 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 11.0 |
| Silica ($SiO_2$) | 90.0 |
| Total solids | 3934.6 |
| Radio-activity, Mache units per liter | 5.4 |

Medicinal classification, weak saline 4, sulphated or (−Cl 4, S), weak radio-active. This is a moderately highly mineralized, calcic, muriated and magnesic and sodic sulphated saline water, radio-activated, possessing diuretic and laxative properties, promoting the secretion of bile and liquefying the intestinal contents. It is said to be of value in the treatment of disease of the liver and chronic constipation, stasis, etc.

## Weatherly's Wells.

(*Nacogdoches County.*)

*Postoffice*, Garrison. *Location*, in eastern Texas; south of Texarkana, 120 miles; north of Beaumont, 120 miles; southeast of Dallas, 150 miles; east of Waco, 170 miles. *Situation*, on the edge of the Coastal Plain region, at an elevation of about 500 feet above sea level. *Access*, via the H. E. and W. T. Railway to Nacogdoches, thence a distance of about 18 miles to the springs, or via Timson Station, thence a shorter distance to the springs. *Hotel*, there are no accommodations for guests. The analysis shows the following mineralization:

WEATHERLY'S WELLS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, P. S. Tilson). Well No. 1. | Well No. 2. |
|---|---|---|
| Potassium chloride (KCl) | 10.79 | trace |
| Sodium chloride (NaCl) | 1327.39 | 814.80 |
| Magnesium chloride ($MgCl_2$) | 142.25 | |
| Calcium chloride ($CaCl_2$) | 111.90 | 1,295.50 |
| Sodium sulphate ($Na_2SO_4$) | 1090.19 | 2,153.16 |
| Magnesium sulphate ($MgSO_4$) | 2851.38 | 3,034.81 |
| Calcium sulphate ($CaSO_4$) | 744.97 | 705.67 |
| Sodium bicarbonate ($NaHCO_3$) | 1388.68 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | trace | 2,235.30 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 72.07 | 239.11 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | 20.12 |
| Ferric oxide ($Fe_2O_3$) | 0.79 | |
| Aluminum oxide ($Al_2O_3$) | 7.07 | |
| Silica ($SiO_2$) | 74.14 | 54.38 |
| Total solids | 7751.62 | 10,552.85 |

Well No. 1, medicinal classification, weak alkaline a4, weak saline 4, sulphated 2 or (−Aa4, −Cl 4, S2). This is a highly mineralized, magnesic and sodic sulphated and alkaline-saline water, sulphuretted, possessing diuretic, antacid and purgative properties. This water should be of value in the treatment of digestive disturbances due to acidity, and in catarrhal conditions of the large intestine. It should also stimulate biliary secretion and promote free movements of the bowels.

Well No. 2, medicinal classification, alkaline b, saline, sulphated 3 or (Ab, Cl, S3). This is a highly mineralized, magnesic and sodic sulphated and magnesic bicarbonated, alkaline-saline (ferruginous) water, sulphuretted, possessing antacid, diuretic, purgative and tonic properties. This is a valuable water in the treatment of digestive disorders due to acidity and hyperacidity; in diseases of the gastro-intestinal tract, where elimination is indicated; in hepatic disorders, due to catarrhal conditions of the bile ducts and to nephrolithiasis. The iron bicarbonate makes it a valuable tonic, indicated wherever an assimilable iron tonic is needed, as in anemia, chlorosis, etc., and in all depraved conditions of the blood and blood-making organs.

These waters are quite similar in the percentage proportions of their predominating chemical constituents, and each is of value in the diseases which the pathological conditions require the medicinal agents contained in these waters. The waters are bottled and shipped in the contiguous territory.

The following springs were once used as resorts:

*Burdett Mineral Wells, P. O.*, Luling, Caldwell County. Hotel accommodations. Once a resort. No definite information nor satisfactory analysis available.

*Capp's Mineral Wells, P. O.*, Longview, Gregg County. There are 2 wells in this area. The waters are said to be purgative in action, due to the sulphate ions in solution. It resembles the German bitter waters. No definite information nor satisfactory analysis available.

*Indian Mineral Springs, P. O.*, Boerne, Kendall County. Location, 30 miles northwest of the city of San Antonio, 1470 feet above sea level. The water is said to be efficacious in debilitated states. No definite information nor satisfactory analysis available.

*Sulphur Springs, P. O.*, Sulphur Springs, Hopkins County. This was once an all-year-round resort; hotels and cottages. No definite information nor satisfactory analysis available.

*Texas Sour Springs, P. O.*, Luling, Caldwell County. Formerly known as the Caldwell Springs. This spring is said to contain free sulphuric acid, and to have once been resorted to by Colonel Davy Crockett. No definite information nor satisfactory analysis available.

*Wootan Wells, P. O.*, Wootan Wells, Robertson County. Hotel and cottages. Once a popular resort. The water is said to be of the sulphate-saline chalybeate class. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:
*Austin Well, P. O.*, Mineral Wells, Palo Pinto County.
*Beauchamp Wells, P. O.*, Blossom, Lamar County.
*Mangum Mineral Well, P. O.*, Mangum, Eastland County.
*Marlin Hot Well, P. O.*, Marlin, Falls County.
*Maurice Wells, P. O.*, Mangum, Eastland County.
*Mitchell Well, P. O.*, Greenville, Hunt County.
*Texas Carlsbad Wells, P. O.*, Mineral Wells, Palo Pinto County.

## UTAH.

Utah extends from 37° to 42° north latitude and from 109° to 114° west longitude, and embraces an area of 84,970 square miles, of which 2780 square miles are covered by water. The shape of the state is a rectangle, 345 miles long from north to south and 270 miles wide. The rectangle is indented in the northeast by a corner of Wyoming, but all the other boundaries of the state are formed by lines of latitude and longitude. The surface of this vast territory is greatly diversified, containing high mountains, broad arid valleys and desert plateaus. The highest elevation in the state is 6100 feet and the lowest, near the southern border, is less than 3000 feet; but, on the other hand many peaks in the state exceed 13,000 feet in height. The Great Salt Lake is situated in the northwest corner of the state is 80 miles long and from 18 to 48 miles wide. In former geological ages this Great Salt Lake covered a vastly greater area than at the present time, the shore lines upon the surrounding mountains having an altitude nearly 1000 feet higher than the present level of the lake. The only other bodies of water of any magnitude are the Bear Lake and Utah Lake, both fresh water and both tributary to the Great Salt Lake. The climate is of the continental type, with sudden changes and great extremes both summer and winter. The mean annual temperature is about 6.15° C. (45° F.), being 22.8° C. (78.59° F.) for the summer and 1.4° C. (30.38° F.) for the winter. The lowest temperature observed at any of the stations was −36.7° C. (34° F. below zero) and the highest 45.9° C. (115° F.).

Utah is credited with having 48 spring localities, with a total of 144 individual springs, 6 of which have been analyzed and 5 used as resorts. The state does not occupy a prominent place as a mineral spring area in any of the older works on mineral waters. Walton mentions but 1 locality and Crook mentions only 6; Peale's list records 50, of which he states only 6 are resorts. Most of the springs are thermic. Alkaline-saline springs predominate, although there are a few chalybeate and sulphuretted waters in different parts of the state. The following list is made up from correspondence with spring owners and physicians.

## Beck's Hot Sulphur Springs.

(*Salt Lake County.*)

*Postoffice*, Salt Lake City. *Location*, in the central northern section Utah; west of Cheyenne, Wyo., 375 miles; north of Denver, Colo., 400 miles. *Situation*, in the heart of the Great Rocky Mountains, at an elevation of 4050 feet above sea level and 40 feet above the surface of the water in the Great Salt Lake. *Access*, via the Southern Pacific Railway System, and for motorists over the great national Pike's Peak Ocean-to-Ocean Highway. *Hotel*, this is the well-known hotel and health resort of Salt Lake City. It is fitted up with sanitarium and bathing departments, bath-houses, swimming pool and restaurant; every modern convenience. The water, on analysis, shows the following mineralization:

BECK'S HOT SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. Hirsching). |
|---|---|
| Potassium chloride (KCl) | 144.49 |
| Sodium chloride (NaCl) | 10,231.44 |
| Magnesium chloride ($MgCl_2$) | 124.48 |
| Calcium chloride ($CaCl_2$) | 111.49 |
| Potassium sulphate ($K_2SO_4$) | 181.43 |
| Sodium sulphate ($Na_2SO_4$) | 2,410.41 |
| Magnesium sulphate ($MgSO_4$) | 451.47 |
| Sodium borate ($Na_2B_4O_7$) | 3.93 |
| Calcium borate ($CaB_4O_7$) | 2.05 |
| Sodium bicarbonate ($NaHCO_3$) | 405.28 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 162.88 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 650.04 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 12.74 |
| Silica ($SiO_2$) | 21.04 |
| Total solids | 14,913.17 |

Gases:
Carbon dioxide and hydrogen sulphide, saturated.

Medicinal classification, weak alkaline b3, strong saline, sulphated 1.5 (−Ab3, +Cl, S 1.5), thermic, carbon-dioxated, sulphuretted. The analysis shows this to be a highly mineralized, thermic, sodic, muriated, sulphated and bicarbonated saline water, sulphuretted and carbon-dioxated, possessing diuretic and purgative properties. The water is perfectly clear, potable and refreshing when taken cold. The baths are said to be very highly efficacious in chronic gout and skin affections, in chronic metallic poisoning and tertiary syphilis, etc.

## Buhler's Hot Springs.

(*Wahsatch County.*)

*Postoffice*, Midway. *Location*, northeast of central Utah; east by south from Salt Lake City, the capital city, 100 miles; east of Eureka,

60 miles. *Situation*, in a beautiful valley, at an elevation of 5560 feet above sea level. *Access*, via the Denver & Rio Grande Railway and the Colorado Springs & Denver Railway, thence a distance of 3 miles by motor to the springs. *Hotel*, the accommodations are primitive, with few modern conveniences. The climate during the summer is ideal, but in the winter the air is crisp and sharp. The resort is open throughout the entire year. The analysis below shows the mineralization:

BUHLER'S HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,0000 (Analyst, H. Harms). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 176.60 |
| Potassium chloride ($KCl$) | trace |
| Calcium chloride ($CaCl_2$) | trace |
| Magnesium chloride ($MgCl_2$) | trace |
| Potassium sulphate ($K_2SO_4$) | 19.60 |
| Sodium sulphate ($Na_2SO_4$) | 21.10 |
| Magnesium sulphate ($MgSO_4$) | 459.30 |
| Calcium sulphate ($CaSO_4$) | 418.00 |
| Sodium biborate ($Na_2B_4O_7$) | trace |
| Sodium arsenate ($Na_2As_2O_3$) | 0.20 |
| Sodium bicarbonate ($NaHCO_2$) | 25.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 92.83 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 786.99 |
| Manganese oxide ($MnO$) | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.41 |
| Silica acid ($SiO_3$) | 20.70 |
| Organic matter | 276.00 |
| Total solids | 2296.73 |
| Temperature, °C. | 41.3 |

Medicinal classification, weak alkaline b2, weak sulphated 2 or (−Ab2, −S2), thermic. The analysis reveals a moderately highly mineralized, thermic, magnesic and calcic sulphated and calcic bicarbonated alkaline water, possessing diuretic and laxative action and faint tonic and alterative properties. The high alkaline content makes the water "very hard" and, therefore, not a desirable water for drinking or general household purposes, but for a bathing establishment the thermic properties are of great value, and should give satisfactory results in chronic rheumatism and chronic joint disturbances and some forms of chronic skin diseases.

## La Verkin Springs.

(*Iron County.*)

*Postoffice*, La Verkin. *Location*, in southwestern Utah; southwest of Salt Lake City, the capital city, 325 miles; east of Tonopah, Nev., 220 miles. *Situation*, east of the Escalante Desert, in the valley of the Rio Virgin River, in the Iron Mountain region, at an elevation of about 3500 feet above sea level. *Access*, via the Southern Pacific

Railway and connections to Cedar City, thence over good macadam highways, through a wonderful mountainous region, full of scenic interest, 40 miles by motor to the springs. *Hotel*, there is a concrete structure, hotel and bathing establishment combined, where patients and guests are entertained throughout the year. There is a large natatorium, 40 by 32 feet, connected with the bathing establishment, for the use of bathers. There are several springs in the area, some welling up in the bed of the Rio Virgin River. The sanitarium is at present using the largest spring. The analysis below shows the mineralization:

LA VERKIN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, P. S. Nice). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 5,944.0 |
| Sodium sulphate ($Na_2SO_4$) | 531.0 |
| Magnesium sulphate ($MgSO_4$) | 596.0 |
| Calcium sulphate ($CaSO_4$) | 1,474.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1,591.0 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 8.0 |
| Silica ($SiO_2$) | 42.0 |
| Total solids | 10,186.0 |
| Gas: | |
| Carbon dioxide (free) | 93.35 |

Medicinal classification, weak alkaline b4, saline 3, calcic sulphated or (−Ab4, Cl 3, CaS). This is a highly mineralized, sodic, muriated, sulphated, bicarbonated alkaline-saline water, possessing diuretic and laxative properties. Approximately 60 per cent of the total solids are in the form of chloride of sodium, 22 per cent in the form of sulphates, of sodium and calcium. The sulphate ions present in solution make it a good water in bowel inactivity.

## Salt Lake Hot Sulphur Springs.

*(Salt Lake County.)*

*Postoffice*, Salt Lake City. *Location*, in northern Utah; south of Ogden City, 35 miles; north of Springville, 50 miles; west of Cheyenne, Wyo. *Situation*, in the heart of the Rocky Mountains, at an elevation of 4060 feet above sea level and 40 feet above the surface of the Great Salt Lake. *Access*, via the Southern Pacific Railway and Pike's Peak Ocean-to-Ocean Highway. *Hotel*, the establishment contains a hotel and sanitarium and bathing establishment, all under one management. The springs are situated on the northern outskirts of the city, and are piped through an 8-inch pipe to the hotel and bathing establishment a commodious structure of more than 50,000 square feet of floor space. Besides separate departments for men and women there are 12 private pools and a number of elegant and ornate private bath-

rooms. A gymnasium has lately been added to the establishment. The water on analysis shows the following mineralization:

SALT LAKE HOT SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, L. G. Gale). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 8,050.0 |
| Magnesium chloride ($MgCl_2$) | 290.0 |
| Calcium chloride ($CaCl_2$) | 1,090.0 |
| Calcium sulphate ($CaSO_4$) | 810.0 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 291.6 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | trace |
| Silica ($SiO_2$) | 180.0 |
| Total solids | 10,711.6 |
| Temperature, °C. | 44.4 |
| Gases: | |
| Carbon dioxide and hydrogen sulphide, saturated. | |
| Flow in gallons per day | 676,000 |

Medicinal classification, strong saline or (+Cl, carbon-dioxated, sulphuretted, thermic). The analysis shows this to be a highly mineralized, thermic, sodic, calcic, muriated saline water, carbon-dioxated, sulphuretted, possessing diuretic and aperient properties. The waters are useful in the treatment of the various ailments for which hot saline sulphur waters are prescribed.

## Utah Hot Springs.

(*Box Elder County.*)

*Postoffice*, Utah Hot Springs. *Location*, in northern Utah; north of the Salt Lake City, 40 miles; south of Bingham, 15 miles; north of Ogden, 9 miles. *Situation*, at the western base of the Wahsatch Mountains; the elevation is 4246 feet above sea level. *Access*, via the Southern Pacific and Union Pacific Railways. *Hotel*, the Hot Springs Hotel is a large commodious structure, with modern conveniences. The bathing establishment contains separate divisions for men and women, with competent masseurs and masseuses. There are 3 large springs in this area. It is said when first discovered they resembled wells, 20 to 30 feet in diameter and 80 to 120 feet in depth, each furnishing a flowing stream of hot water, clear and sparkling.

Medicinal classification, strong saline 2 or (+Cl 2), thermic. The analysis shows this to be a highly mineralized, thermic, sodic and potassic, muriated, saline water, carbon dioxated, possessing diuretic and purgative properties. This is a strong muriated, saline water and, in addition to the mineral ingredients, the water contains a large amount of organic matter principally algæ. This parasitic growth forms rapidly on the inside of the reservoir, and in bathing imparts an unctuous feeling, an oleaginous effect to the skin. The bathing

establishment is very popular and much resorted to by sufferers of rheumatism, gout, syphilis, etc., and by women for disorders of the menstrual function.

UTAH HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. S. F. Baird). |
|---|---|
| Potassium chloride ($KCl$) | 1,671.35 |
| Sodium chloride ($NaCl$) | 17,999.43 |
| Magnesium chloride ($MgCl_2$) | 18.29 |
| Calcium chloride ($CaCl_2$) | 2,915.37 |
| Calcium sulphate ($CaSO_4$) | 308.99 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 326.05 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 4.26 |
| Silica ($SiO_2$) | 45.99 |
| Total solids | 23,289.73 |
| Temperature, °C. | 62.2 |
| Gases, cc. per liter: | |
| Carbon dioxide | 78.2 |
| Flow in gallons per day | 60,000 |

## Warm Springs.

*(Salt Lake County.)*

*Postoffice*, Salt Lake City. *Location*, in the center of the northern section of the state; west of Cheyenne, Wyo., 375 miles; northeast of Denver, Colo., 400 miles. *Situation*, in the heart of the Great Rocky Mountains, in Salt Lake City, 4060 feet above sea level, 20 feet above the general level of Salt Lake Valley and 40 feet above the level of Salt Lake itself. The springs are the property of the municipality of Salt Lake City, and are situated less than 1½ miles from the heart of the business district. *Access*, via the Southern Pacific Railway System, and for motorists via the great national highway, Pike's Peak Ocean-to-Ocean Highway. *Hotels*, there are a number of splendid hotels in the city. The city has recently erected a large municipal bathing establishment, 213 feet in length and 109 feet in depth, 3 stories in height. The equipment is modern; separate departments for both men and women. The establishment is equipped with modern appurtenances throughout. Of the great variety of warm springs in the state, the most noted and best known are the municipally owned Warm Springs, within the corporate limits of Salt Lake City. This spring issues from a broken, rocky formation, just west of the Wahsatch fault, and as it pours from the crust of the earth it presents a bluish tint, gradually becoming clear on standing. The waters are limpid and have a distinct odor of sulphuretted hydrogen. It has been said of these waters that "It is a Harrowgate water, abounding in sulphur." It is highly mineralized, as the analysis shows. Three fluid ounces of the water evaporated to dryness in a platinum disk

gives $8\frac{1}{2}$ gr. of solid saline matter. It is slightly charged with hydrosulphuric-acid gas, and is a pleasant saline mineral water, having the valuable properties of saline sulphur springs.

WARM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, N. E. McLachlan). |
|---|---|
| Sodium chloride (NaCl) | 7,912.31 |
| Potassium chloride (KCl) | 343.22 |
| Magnesium chloride ($MgCl_2$) | 509.24 |
| Calcium chloride ($CaCl_2$) | 1,094.55 |
| Calcium sulphate ($CaSO_4$) | 1,855.02 |
| Magnesium sulphate ($MgSO_4$) | 106.51 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 521.64 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 3.20 |
| Silica ($SiO_2$) | 40.00 |
| Total solids | 12,385.69 |
| Temperature, °C. | 41 |
| Gas, cc. per liter: | |
| Hydrogen sulphide | 8.4 |
| Flow in gallons per day | 789,672 |

Medicinal classification, strong saline calcic sulphated or (+Cl CaS), thermic, sulphuretted. The analysis shows this to be a highly mineralized, thermic, sodic and calcic, muriated and sulphated saline water, sulphuretted.

Hot sulphur baths in this water is said to be very efficacious in the treatment of rheumatism, rheumatic arthritis, sciatica and skin diseases.

The following springs were once used as resorts:

*The Cliff Springs, P. O.*, Collinston Station, Box Elder County. There are about 30 springs in this area, some of them of immense capacity. The largest spring is 400 by 200 feet across, and its depth is said to have never been ascertained. The current from this spring is sufficient to run a small mill. The elevation is 4200 feet above sea level. The Wahsatch Mountains are nearby. No definite information nor satisfactory analysis available.

*Virgin Hot Springs, P. O.*, Washington, Washington County. The situation is in a rugged, mountainous region, 3200 feet above sea level. The waters are of the thermic class, but no definite information nor satisfactory analysis available.

*Wasatka Mineral Springs, P. O.*, Salt Lake City, Salt Lake County. This is sometimes called the Milk Springs, from the fact that the water is peculiarly soft and has a milk-like flavor. During recent years this spring is said to have come into extensive use. No definite information nor satisfactory analysis available.

## VERMONT.

Vermont extends from 42° to 45° north latitude and from 71°25′ to 73°26′ west longitude, and comprises an area of 9565 square miles, of which 430 square miles are covered by water. The state measures 158 miles from north to south and 41 to 90 miles from east to west. The surface of the state is greatly diversified, and the scenery everywhere is attractive to the eye, and often grand and sublime. The Green Mountains cover practically the whole state with an irregular mass of rounded hills, peaks and ridges, so that no portion of any great extent is level. The range enters the state at the southwestern corner and extends northward as a single range with outlying hills until it reaches the center of the state, where it divides into several parallel ranges, taking a northeast direction. The crest of the mountain range has an elevation of 3000 feet, Mount Mansfield, the highest peak, reaching 4364 feet elevation. The state has numerous small streams which flow into Lake Champlain and Lake Memphramagog and into the Connecticut River. The climate of Vermont is rigorous, but healthful and bracing. The summers are cool and generally pleasant, and the winters are very severe and prolonged. The normal mean temperature at Burlington is −7.8° C. (18° F.) for January, and for July 23.5° C. (70.4° F.); the maximum rarely exceeds 32.2° C. (90° F.) and the minimum in the mountains falls to −34.4° C. (30° F. below zero).

Vermont is credited with having 47 spring localities, with a total of 74 individual springs, of which 8 have been analyzed, and in times past 11 were used as resorts. The prevailing class of springs in this state are sulphuretted waters; a few alkaline and iron waters are found, but none of them has attained a national celebrity, but several are quite important and furnish valuable waters. Walton mentions 8 spring localities and Crook mentions 10. The following list is made up from correspondence with spring owners and from the existing literature on the subject.

### Clarendon Springs.

*(Rutland County.)*

*Postoffice,* Clarendon Springs. *Location,* in the western part of the state; southwest of Rutland, 10 miles; southwest of Montpelier, the capital city, 60 miles. *Situation,* among the green hills, in the heart of the Green Mountains, at an elevation of 1200 feet above sea level. The springs, 4 in number, are situated in a beautiful valley, surrounded by a picturesque panorama of wooded hills. *Access,* via West Rutland, on the Delaware & Hudson Railway, thence by motor 3 miles to the springs. *Hotel,* there is a commodious resort hostelry, with modern conveniences; besides a number of comfortable cottages. This

resort has been popular since 1776, and annually entertains from 1500 to 2500 guests during the season, May to October. The analysis below shows the mineralization:

CLARENDON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Rickets & Banks). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 1.85 |
| Sodium chloride (NaCl) | 2.83 |
| Sodium sulphate ($Na_2SO_4$) | 5.74 |
| Magnesium sulphate ($MgSO_4$) | 3.10 |
| Sodium nitrate ($NaNO_3$) | 3.02 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 133.58 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 209.21 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.70 |
| Silica ($SiO_2$) | 14.01 |
| Total solids | 374.04 |
| Temperature, °C. | 10 |
| Gases, cc. per liter: | |
| Carbon dioxide (free) | 2.2 |
| Carbon dioxide, set free from evaporation to dryness | 49.2 |
| Flow in gallons per day | 28,800 |

Medicinal classification, weak alkaline b or (−Ab). The analysis shows this to be a lightly mineralized, calcic, magnesic, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic and antacid properties. Practically 90 per cent of the salts in solution are in the form of the bicarbonates of calcium and magnesium, which accounts for its pleasing alkalinity. The water flows from the bosom of Mother Nature, sparkling with life and purity. It is highly endorsed by the profession in disturbances of the stomach, due to acidity and hyperacidity. It is also mildly aperient in action, and its continued use aids digestion and increases the secretion of the intestinal mucosa.

## Equinox Spring.

### (*Bennington County.*)

*Postoffice*, Manchester. *Location*, in southwestern Vermont; north of Bennington, the county seat, 20 miles; south of Rutland, 30 miles; west of Bellows Falls, 31 miles. *Situation*, at the foot of Mount Equinox, issuing from the side of a high hill, 1500 feet above the valley of the Battenkill River, and 2500 feet above tidewater, overlooking the village of Manchester and the Battenkill River Valley. *Access*, via the New York Central Lines and connections. *Hotel*, there is a first class resort hostelry with modern conveniences. The analysis shows the mineralization:

EQUINOX SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 0.80 |
| Sodium chloride (NaCl) | 1.35 |
| Sodium sulphate ($Na_2SO_4$) | 2.89 |
| Sodium nitrate ($NaNO_3$) | 2.43 |
| Sodium bicarbonate ($NaHCO_3$) | 1.46 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 10.63 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 21.37 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.78 |
| Silica ($SiO_2$) | 25.07 |
| Total solids | 77.78 |
| Temperature, °C. | 6.7 |
| Gases, cc. per liter: | |
| Carbon dioxide, set free on evaporation | 5 |
| Flow in gallons per day | 86,400 |

The analysis shows a very lightly mineralized, calcic and magnesic, bicarbonated alkaline water, possessing diuretic and slight antacid properties. Approximately 41 per cent of the salts in solution are in the form of the bicarbonates of calcium and magnesium, with smaller amounts of the bicarbonates and sulphate of sodium.

## Middletown Springs.

(*Rutland County.*)

*Postoffice,* Middletown Springs. *Location,* in western Vermont; southwest of Montpelier, the capital city, 62 miles; north of Bennington, 40 miles; south of Burlington, 65 miles; southwest of Rutland, the county seat, 14 miles. *Situation,* on the westerly slope of the Green Mountains, near the north bank of the Poultney River, at an elevation of 3000 feet above tidewater. *Access,* via the Delaware & Hudson Railway to Poultney, thence by motor, a distance of 4 miles, to the springs. *Hotel,* there is a large commodious resort hostelry, with comfortable accommodations. There are 2 springs in the area, the Montvert Spring, a freestone water, is used in the hotel, and the Middletown Spring, of which the analysis below shows the mineralization:

MIDDLETOWN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, P. Collier). |
|---|---|
| Potassium chloride (KCl) | 18.48 |
| Sodium chloride (NaCl) | 18.90 |
| Calcium sulphate ($CaSO_4$) | 20.53 |
| Magnesium sulphate ($MgSO_4$) | 16.77 |
| Sodium bicarbonate ($NaHCO_2$) | 74.38 |
| Magnesium bicarbonate ($MgHCO_3$) | 29.10 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 77.61 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 30.76 |
| Aluminum oxide ($Al_2O_3$) | 1.19 |
| Silica ($SiO_2$) | 1.00 |
| Total solids | 288.72 |

The analysis shows a lightly mineralized, calcic, sodic, ferric and magnesic bicarbonated, alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, tonic and slight aperient properties. The predominating chemical constituents in this water are the bicarbonates of calcium, sodium, iron and magnesium, with a small amount of the sulphates of calcium and magnesium, and the chlorides of sodium and potassium. The waters have been used and highly recommended in the treatment of gout, rheumatism, acid dyspepsia and as a general tonic and blood builder in anemia and chlorosis.

## Missisquoi Spring.

### (*Franklin County.*)

*Postoffice*, Sheldon. *Location*, in northwestern Vermont; northeast of St. Albans, the county seat, 8 miles; north of Montpelier, the capital city, 50 miles; south of the Canadian boundary line, 8 miles. *Situation*, in the outlying foothills of the northern end of the Green Mountains, lying in the beautiful valley of the Missisquoi River, at an elevation of 2000 feet above tidewater. The scenic vistas are superb, with Lake Champlain lying to the westward. *Access*, the Central Vermont Railway to St. Albans, thence via the Missisquoi Valley Railway to within a short distance of the springs. *Hotel*, there are very fair accommodations at Sheldon. The waters from this spring are bottled and shipped. The bottling plant is modern in construction and equipment. The analysis below shows the mineralization:

MISSISQUOI SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Skinner). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 2.25 |
| Sodium chloride (NaCl) | 2.52 |
| Sodium sulphate ($Na_2SO_4$) | 26.03 |
| Magnesium sulphate ($MgSO_4$) | 1.99 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 83.46 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 181.25 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.27 |
| Calcium silicate ($CaSiO_3$) | 1.66 |
| Silica ($SiO_2$) | 19.00 |
| Total solids | 320.43 |
| Temperature, °C. | 6.7 |
| Gas, cc. per liter: | |
| Carbon dioxide set free from evaporation to dryness | 37.8 |
| Flow in gallons per day | 360 |

The analysis shows this to be a lightly mineralized, calcic, magnesic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic, antacid and slight aperient properties. Approximately 83 per cent of

the salts in solution are in the form of the bicarbonates of calcium and magnesium, with a small amount of the sulphate of sodium.

### Sheldon Springs.

(*Franklin County.*)

*Postoffice*, Sheldon. *Location*, in northwestern Vermont; north of Montpelier, the capital city, 52 miles; northeast of St. Albans, the county seat, 10 miles; south of the Canadian boundary line, 8 miles. *Situation*, on the banks of the Missisquoi River and in the valley of the same, at an elevation of 2000 feet above sea level and within sight of Mount Mansfield and others of the Green Mount Range. Delightful climate, bracing and invigorating atmosphere. *Access*, via the Central Railway of Vermont to St. Albans, thence via the Missisquoi Valley Railway to Sheldon, only a short distance, 2 miles, from the springs. *Hotel*, there is a modern resort hostelry offering comfortable accommodations. There are 3 springs in this area: The Central Spring is on the edge of the village; the Vermont Spring, ½ mile away; the Sheldon Spring, of which we give the analysis below, is near the hotel.

SHELDON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. S. D. Hayes). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride ($NaCl$) | 36.78 |
| Potassium chloride ($KCl$) | 25.66 |
| Sodium sulphate ($Na_2SO_4$) | 21.21 |
| Magnesium sulphate ($MgSO_4$) | 8.55 |
| Sodium bicarbonate ($NaHCO_3$) | 69.29 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 33.36 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 104.87 |
| Ferric oxide ($Fe_2O_3$) | 0.17 |
| Silica ($SiO_2$) | 24.98 |
| Total solids | 324.87 |

The analysis shows this to be a lightly mineralized, calcic, sodic and magnesic bicarbonated alkaline-saline water, carbon-dioxated, possessing diuretic and antacid action. Its use has given satisfaction in the treatment of uric acid, renal and vesical calculi, gout and catarrhal disorders of the bladder.

The following springs were once used as resorts:

*Alburgh Springs*, *P. O.*, Alburgh Springs, Grand Isle County. Two hotels. This is an old-time New England resort; its use dating back to 1816. Location, on the shores of the Missisquoi Bay. There are 2 springs in this area, 1 a saline sulphuretted and the other a ferruginous. No definite information nor satisfactory analysis available.

*Dearborn Springs*, *P. O.*, Woodstock, Windsor County. This was formerly known as the Old Sanderson Spring. Located about 3 miles

from the famous Woodstock Inn. The spring is said to have been discovered in 1830, and rapidly gaining a considerable reputation as a medicinal water. The location is about 1600 feet above sea level and 900 feet above Woodstock Park. The waters are said to be very cold, almost an icy temperature. No definite information nor satisfactory analysis available.

*Elgin Spring, P. O.*, Vergennes, Addison County. Located in the beautiful Champlain Valley. Hotel and boarding houses. The waters are said to have once enjoyed a considerable reputation, and it is claimed that they resemble the waters of Seidlitz and Pullna, in Bohemia. No definite information nor satisfactory analysis available.

*Highgate Spring, P. O.*, Highgate, Franklin County. The location is 12 miles north of St. Albans. The water is claimed to be of the sulpho-saline variety, but no definite information nor satisfactory analysis available.

*Montebello Springs, P. O.*, Newbury, Orange County. This was formerly known as Newbury Springs. Located in the northern Connecticut Valley. Hotels. The water is claimed to be a calcic, bicarbonated, alkaline water. No definite information nor satisfactory analysis available.

*Vermont Mineral Springs, P. O.*, Newfane, Windham County. Location, 15 miles north of Brattleboro, situated on Putney Heights, 700 feet above sea level. There are 2 springs in this area. It was formerly run as a resort, but no definite information nor satisfactory analysis available.

*Wilden Springs, P. O.*, St. Albans, Franklin County. Situated 2 miles west of Lake Champlain. Hotels. This place was a popular resort in the past, but so far as we can learn, it is not now employed for medicinal purposes. No definite information nor satisfactory analysis available.

The following spring reported the sale of water in 1924:

*Cold Spring, P. O.*, Wells, Rutland County.

## VIRGINIA.

Virginia extends from 36°30′ to 39°27′ north latitude and from 75°10′ to 83°30′ west longitude, and comprises an area of 42,450 square miles, of which 2325 square miles are covered by water. The greatest breadth from north to south is 192 miles; the southern boundary is a straight line, 440 miles long, but the other outlines are extremely irregular, following the Appalachian ridges on the northwest and the Potomac River on the northeast. Topographically, the surface of the state is divided into three great regions; the Coastal Plain covers the tidewater country, which includes the region traversed by the James, York, Potomac and Rappahannock Rivers. This is a low, level, marshy, country, west of which begins the Piedmont Plain, which rises by a low rocky escarpment, whose eastern portion is known as

the middle country; the latter has an elevation of 100 to 500 feet. The Piedmont Plain has an elevation of from 500 feet elevation in the eastern section to 1000 feet on its western side, where it reaches to the foothills of the Blue Ridge Mountains, where the elevation reaches 2500 to 3000 feet. West of this range is the beautiful Shenandoah Valley, lying between the Blue Ridge on the east and the Appalachian Mountains on the west, the latter forming the boundary line with West Virginia. The great plateau of the Shenandoah Valley, embracing an area of 7500 square miles, forms one of the most beautiful scenic regions in the United State; here is the Natural Bridge, one of the wonders of the world. It is impossible in the limited space to dwell upon the many charming features of this favored spot, only to say that Dame Nature was lavish in dispensing her charms, some of which she must have intended for the Garden of Eden. The climate of Virginia is salubrious, pleasing and healthful. The mean annual temperature, as observed at Richmond, is 13.28° C. (57.53° F.); the temperature for January is 2.8° C. (37° F.); for July, 24.10° C. (76° F.); the extremes of temperature noted rarely goes above 37.8° C. (100° F.) or below 23.3° C. (10° F.). In the uplands the climate is dry and healthful; near the coast there is some humidity. West of the Blue Ridge the summers are cool and delightful, while the winters, especially in the mountains are cold.

Virginia is credited with having 97 spring localities, with a total of 307 individual springs, 75 of which have been analyzed and 54 used as resorts. The state has long been renowned for the number and value of its mineral springs, and even at the present time it stands well toward the head of the list in this respect, only California having a greater number. All varieties of mineral waters are shown in the Virginia reports, chalybeate and sulphuretted waters predominating, but there are great varieties of other classes of waters, including thermic; Hot Springs is one of the great spas of the country. Walton, in his work, mentions 33 spring localities. Moorman mentions 32 spring localities and Crook records 33 spring localities, while Peale's list numbers 75. The following list was obtained to some extent from standard works on the subject from personal visitations and from correspondence with physicians and spring owners. The list is fairly representative of the springs in active use at the present time.

### Alleghany Springs.

(*Montgomery County.*)

*Postoffice,* Christiansburg. *Location,* in the western portion of the state; slightly southwest of Richmond, the capital city, 245 miles; west of Petersburg, 240 miles; south of White Sulphur Springs in the state of West Virginia, 63 miles. *Situation,* on a beautiful mountain stream which forms the head waters of the Roanoke River, on the

eastern slope of the Blue Ridge Mountains, at an elevation of 1800 feet above sea level. *Access*, via the Norfolk & Western Railway to Christiansburg, thence a short distance by motor to the spring. *Hotel*, there is a commodious resort hostelry. In addition there are three score or more of bungalows and cottages, which offer additional accommodations. There is only 1 spring, of which we give the analysis herewith:

ALLEGHANY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. F. A. Genth). |
|---|---|
| Sodium chloride (NaCl) | 4.79 |
| Potassium sulphate ($K_2SO_4$) | 63.30 |
| Sodium sulphate ($Na_2SO_4$) | 29.42 |
| Magnesium sulphate ($MgSO_4$) | 870.56 |
| Calcium sulphate ($CaSO_4$) | 1972.61 |
| Aluminum phosphate ($Al_2PO_4$) | 0.51 |
| Magnesium nitrate ($Mg[NO_3]_2$) | 55.09 |
| Aluminum nitrate ($Al_2[NO_3]_3$) | 9.58 |
| Lithium bicarbonate ($LiHCO_3$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 11.88 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 86.20 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 1.66 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 0.55 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.43 |
| Cobalt, lead, zinc, bicarbonate (Co, Zn, Pb, $Cu[HCO_3]_2$) | traces |
| Calcium fluoride ($CaF_2$) | 0.34 |
| Aluminum silicate ($Al_2[SiO_3]_3$) | 3.59 |
| Silica ($SiO_2$) | 15.5 |
| Crenic and apocrenic acids | traces |
| Total solids | 3129.56 |

Medicinal classification, calcic sulphated 1.4 or (CaS 1.4). This is a moderately highly mineralized, calcic, magnesic sulphated saline water, sulphuretted, possessing diuretic, cathartic, tonic, alterative and detergent properties. This water is distinguished by the great variety of its chemical constituents, the most important of which are the sulphates; but it is undoubtedly true that some of the other constituents, though present in small quantities modify the physiological action of the water to a very considerable extent. When administered in large quantities it acts actively on the kidneys and lower bowel, operating with special activity upon the mucous membranes of the lower bowel. The water has a wide reputation in the treatment of digestive disorders. Excellent results have been obtained from its use in diseases of the nervous system and in diseases of the liver and kidneys. It is also recommended by the profession as an adjuvant in the treatment of anemia and chlorosis, general debility and other disorders where a tonic and reconstructive medicine is indicated.

## Bath Alum Springs.

(*Bath County.*)

*Postoffice*, Millboro. *Location*, in the extreme midwestern portion of the state, in the heart of the Alleghany Mountains; 10 miles from

the Virginia Hot Springs. *Situation*, at the base of Warm Springs Mountain, at an elevation of 2500 feet above tidewater and surrounded by a rugged hilly country, where deep ravines and shadowed valleys, covered with mountain laurel and rhododendron, presents a panorama of picturesque charm and beauty. *Access*, via Millboro Station on the main line of the Chesapeake & Ohio Railway (all through trains stop), thence via motor 8 miles to the springs. *Hotel*, the Allegendoah Club, a colonial building, beautiful in exterior design, with all the elusive charm and atmosphere of postcolonial days, completely modernized with all the conveniences of a metropolitan club. This is a unique institution, being essentially a resort for well people who want to stay well, for successful people whose future depends upon continued good health. The Old Bath Alum Springs is now the National Christian Conservation Association, for the physical, moral and spiritual conservation of young boys and girls, as well as a high-class all-year-round resort for adults. The mineral springs, 7 in number, are noted for their medicinal properties. Below is given the analysis of Spring No. 2, which shows the following mineralization:

BATH ALUM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. H. Taylor). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 2.4 |
| Potassium sulphate ($K_2SO_4$) | 3.1 |
| Sodium sulphate ($Na_2SO_4$) | 21.6 |
| Magnesium sulphate ($MgSO_4$) | 7.8 |
| Calcium sulphate ($CaSO_4$) | 29.4 |
| Manganous sulphate ($MnSO_4$) | 0.6 |
| Ferrous sulphate ($FeSO_4$) | 458.4 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 513.5 |
| Silica ($SiO_2$) | 33.3 |
| Sulphuric acid ($H_2SO_4$), free | 49.3 |
| Total solids | 1119.4 |
| Gas, cc. per liter: | |
| Carbon dioxide | 20.1 |

Medicinal classification, weak acid aluminic and ferruginous sulphated 3, weak ferruginous or (−Ac, Al, Fe S, −Fe). This is a moderately mineralized ferruginous aluminic sulphated acid water, faintly carbon-dioxated, possessing astringent and tonic properties, and has been found useful in the treatment of chronic diarrhea and relaxed conditions of the mucous membranes of the gastro-intestinal tract. The profession highly endorses the water in the above conditions. The climatic advantages are delightful, cool in summer, mild in winter; just enough snap in the air in fall and spring to give that refreshing tonic, so much needed and welcomed by "cliff dwellers" in our large cities.

## Bear Lithia Springs.

(*Rockingham County.*)

*Postoffice,* Elkton. *Location,* in the western section of the state; northwest of Richmond, the capital city, 125 miles; southwest of Washington City, 150 miles; east of Harrisonburg, 25 miles. *Situation,* in the beautiful valley of Virginia, amid a picturesque panorama, formed by the Shenandoah Mountains on the west and the Blue Ridge Mountains on the east. *Access,* via Elkton Station, on the Baltimore & Ohio Railway, and via the Valley Turnpike, one of the wonderful highways for motor travel, through the beautiful Shenandoah Valley. *Hotel,* no accommodations for guests at the springs. The waters from this spring have been known to the white man since 1723, when King George II, by royal grant, decreed that the waters of this spring should be free forever to the people of Rockingham County. Before the coming of the "pale face" the red men of the forest knew of and appreciated the curative properties of the waters, and repaired here to be freed from their ills. The analysis below shows the mineralization:

BEAR LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, John W. Mallet). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.063 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 3.100 |
| Sodium chloride (NaCl) | 1.200 |
| Potassium iodide (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 4.300 |
| Sodium nitrate ($NaNO_3$) | 1.220 |
| Sodium nitrite ($NaNO_2$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 11.00 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 62.00 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 73.700 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.200 |
| Silica ($SiO_2$) | 15.500 |
| Total solids | 172.283 |
| Temperature, °C. | 11.1 |
| Gases, cc. per liter: | |
| Carbon dioxide (free) | 6.8 |
| Carbon dioxide from bicarbonates on evaporation to dryness | 21.2 |
| Flow in gallons per day | 3,000,000 |

The analysis shows this to be a lightly mineralized, calcic and magnesic, bicarbonated alkaline water, slightly carbon-dioxated, possessing diuretic, tonic and alterative properties. It is highly endorsed in disorders of the bladder and kidneys and in disturbances of the gastric organs due to hyperacidity. The Bear Lithia Spring is 100 feet long, 60 feet wide and 3 feet deep, and so clear that it often presents an optic illusion, causing the observer to question, is it empty?

## Bedford Iron Alum Springs.

(*Campbell County.*)

*Postoffice*, Bedford Springs. *Location*, central Virginia; east of Roanoke, 65 miles; west of Farmville, 65 miles; south of Lexington, 50 miles. *Situation*, in the Natural Bridge section of the state, not far from Bedford Village of Revolutionary fame. The general elevation is about 1300 feet above sea level. It is surrounded by a section of country abounding in vistas of great scenic beauty; 20 miles away the Peaks of Otter, the highest peaks of the Blue Ridge in Virginia, with an altitude of 5307 feet above sea level. *Access*, via the Norfolk & Western Railway to Forest Depot, thence by motor 4 miles to the springs. *Hotel*, there used to be good hotel accommodations here, but in late years we learn it has not kept pace with the demands of the public. The analysis below shows the mineralization:

BEDFORD IRON ALUM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, M. B. Harris). |
|---|---|
| Sodium chloride ($NaCl$) | 3.6 |
| Potassium sulphate ($K_2SO_4$) | 12.1 |
| Sodium sulphate ($Na_2SO_4$) | 14.8 |
| Magnesium sulphate ($MgSO_4$) | 215.1 |
| Calcium sulphate ($CaSO_4$) | 85.3 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 413.5 |
| Manganese sulphate ($MnSO_4$) | 1.5 |
| Lithium sulphate ($Li_2SO_4$) | 4.1 |
| Cobalt sulphate ($CoSO_4$) | 1.2 |
| Nickel sulphate ($NiSO_4$) | 0.6 |
| Zinc sulphate ($ZnSO_4$) | 1.2 |
| Ferrous sulphate ($FeSO_4$) | 10.0 |
| Ferric sulphate ($Fe_2[SO_4]_3$) | 222.1 |
| Copper sulphate ($CuSO_4$) | 10.2 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 5.1 |
| Ammonium nitrate ($NH_4NO_3$) | 4.4 |
| Magnesium nitrate ($Mg[NO_3]_2$) | 4.1 |
| Calcium fluoride ($CaF_2$) | trace |
| Silica ($SiO_2$) | 28.9 |
| Sulphuric acid ($H_2SO_4$) | 68.5 |
| Total solids | 1106.3 |
| Gases, cc. per liter: | |
| Carbon dioxide | 24.0 |
| Oxygen | 4.3 |
| Nitrogen | 6.4 |
| Total gases, cc. per liter | 34.7 |

Medicinal classification, weak acid aluminic ferric sulphated 2, very weak ferruginous 2.5 or (−AcAlFe2, −−Fe2.5). This is a moderately mineralized, magnesic, calcic, ferric, aluminic sulphated, acid water, azotized, possessing astringent, tonic, alterative and diuretic properties. In small dosage, internally, these waters have been used in the

treatment of chronic diarrhea and dysentery. The large amount of the various sulphate ions in solution in moderate dosage produce aperient action; in large dosage, purgative action.

## Berry Hill Mineral Springs.

*(Culpeper County.)*

*Postoffice,* Culpeper. *Location,* slightly northwest of Richmond, the capital city, 100 miles; southwest of Washington City, 87 miles. *Situation,* on western edge of the tidewater section of the state, in a beautiful valley of a small stream, which empties into the Rappahannock River a few miles to the eastward. The elevation is about 700 feet above sea level. *Access,* via the Southern Railway System, thence only a short distance to the springs. *Hotel,* no accommodations at the springs but good hotels in Culpeper. The analysis below shows the mineralization:

BERRY HILL MINERAL SPRINGS.

| Hypothetical combinatiosn. | Parts per1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.157 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 6.500 |
| Sodium chloride (NaCl) | 37.600 |
| Potassium bromide (KBr) | trace |
| Potassium iodide (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 459.600 |
| Magnesium sulphate ($MgSO_4$) | 291.500 |
| Calcium sulphate ($CaSO_4$) | 1618.700 |
| Sodium metaborate ($NaBO_2$) | heavy trace |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium nitrite ($NaNO_2$) | 0.014 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 197.000 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.500 |
| Mangano-manganic oxide ($Mn_3O_4$) | trace |
| Silica ($SiO_2$) | 27.600 |
| Total solids | 2643.171 |
| Gases, cc. per liter: | |
| Carbon dioxide, free | 1.4 |
| Carbon dioxide, set free on evaporation | 27.7 |

Medicinal classification, calcic sulphated or (CaS). This is a moderately highly mineralized, calcic sulphated and bicarbonated saline water, possessing diuretic, laxative, tonic and alterative properties. This water has been used with pleasing results in the treatment of gastric and intestinal disorders, diseases of the liver and in irritable conditions of the genito-urinary tract. The waters have the endorsement of the local profession, who know best the therapeutic virtues of the waters. The waters are bottled and shipped commercially.

## Buckhead Springs.

(*Chesterfield County.*)

*Postoffice*, Buckhead Springs. *Location*, east of central Virginia; west from the Chesapeake Bay, 100 miles; south of Washington City, 150 miles; east of Lynchburg, 140 miles. *Situation*, in slightly rolling region, about 450 feet above sea level, surrounded by a fertile farming country, healthful, well drained and salubrious. *Access*, via the Norfolk & Western Railway and connecting lines. *Hotel*, no preparations for the accommodations of guests. The spring house is improved, covered with glass and the water is conveyed to the packing plant through enameled pipe. The analysis shows the mineralization:

BUCKHEAD SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, H. Froehling). |
|---|---|
| Lithium chloride ($LiCl$) | 0.016 |
| Potassium chloride ($KCl$) | 3.610 |
| Sodium chloride ($NaCl$) | 1.140 |
| Magnesium chloride ($MgCl_2$) | 10.510 |
| Calcium chloride ($CaCl_2$) | 1.570 |
| Potassium sulphate ($K_2SO_4$) | 1.260 |
| Sodium nitrate ($NaNO_3$) | 11.570 |
| Sodium phosphate ($Na_2HPO_4$) | 0.017 |
| Sodium arsenate ($Na_3AsO_4$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 0.570 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 5.030 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 0.020 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | 0.040 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.360 |
| Aluminum oxide ($Al_2O_3$) | 1.000 |
| Silica ($SiO_2$) | 7.480 |
| Total solids | 44.193 |
| Gases: | |
| Carbon dioxide, free | 6.4 |

The analysis shows this to be a slightly mineralized magnesic, sodic, muriated, nitrated, bicarbonated alkaline water, possessing diuretic properties. It is claimed to be useful in gout, rheumatism and digestive disorders, etc. It is bottled and shipped extensively.

## Buffalo Lithia Springs.

(*Mecklenburg County.*)

*Postoffice*, Buffalo Lithia Springs. *Location*, in southeastern Virginia; north of the Virginia and North Carolina boundary line, $3\frac{1}{2}$ miles; east of Danville, 50 miles; west of Norfolk, 148 miles; southwest of Richmond, the capital city, 116 miles; north of Raleigh, N. C., 80 miles. *Situation*, in a beautiful section of country, known as the Buffalo Hills, a broken rolling district, comprising about 6 square miles, at an elevation of 550 feet above sea level, and surrounded by rich agricultural country, well drained, healthful and salubrious. *Access*, via the Norfolk Division of the Southern Railway to Clarke-

ville, thence 6 miles by motor to the springs, or via Buffalo Junction, thence a distance of 3 miles to the springs, or via the Buffalo Branch Line from the Junction, which delivers passengers to the depot within the grounds. *Hotels*, this is a typical old-fashioned Virginia resort, where the best families of the South have sojourned, as pleasure-loving and health-seeking guests. The new Buffalo Chateau, now under contemplation, is to be of pleasing architectural design, of granite, steel and concrete construction, with 500 guest-rooms, single and *en suite*, with every modern convenience. The bathing establishment will be modern in construction and equipment, with every known appliance for the scientific application of the latest knowledge in hydrotherapy and balneotherapy. The ornate interior will impress the bather with a sense of luxury which makes bathing a pleasure. Every known physiotherapeutic method of treatment will be available here; every advantage of the highest type of sanitarium treatment will be given without the atmosphere of hospitalization. The 1600-acre estate insures a bountiful supply of fruits, berries and fresh vegetables; the dairy, an abundance of fresh cream, sweet butter and milk; poultry yards, an abundance of fresh eggs and fowl for the table. There are numerous springs in this area, the analyses of the more important ones are given below, showing the mineralization as follows, viz:

BUFFALO MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. | | | | | | |
|---|---|---|---|---|---|---|---|
| | Spring No. 1.[1] | Spring No. 2.[2] | Spring No. 3.[3] | Spring No. 4.[2] | Spring No. 5.[3] | Spring No. 6.[4] | Spring No. 8.[2] |
| Ammonium chloride ($NH_4Cl$) | 0.05 | ... | ... | 0.07 | 0.03 | ... | 0.025 |
| Lithium chloride ($LiCl$) | 0.45 | 0.29 | trace | ... | ... | ... | trace |
| Potassium chloride ($KCl$) | 0.39 | 9.90 | ... | 10.80 | 2.80 | ... | 4.060 |
| Sodium chloride ($NaCl$) | ... | 6.74 | 3.80 | 125.80 | 10.90 | 14.6 | 2.890 |
| Magnesium chloride ($MgCl_2$) | ... | ... | ... | 158.20 | | | |
| Sodium iodide ($NaI$) | ... | ... | trace | | | | |
| Sodium sulphate ($Na_2SO_4$) | 66.80 | 53.60 | ... | .... | 3.20 | ... | 3.500 |
| Potassium sulphate ($K_2SO_4$) | 6.40 | | | | | | |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | 52.41 | | | | |
| Magnesium sulphate ($MgSO_4$) | 26.40 | 41.29 | 2.59 | 48.30 | | | |
| Calcium sulphate ($CaSO_4$) | 397.40 | 459.72 | 40.52 | ... | ... | 15.6 | trace |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 2.30 | 1.19 | trace | trace | trace | | |
| Sodium nitrate ($NaNO_3$) | trace | 4.85 | ... | 48.20 | 4.30 | ... | 1.350 |
| Sodium nitrite ($NaNO_2$) | ... | trace | ... | trace | | | |
| Sodium metaborate ($NaBO_2$) | ... | ... | ... | trace | | | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | ... | ... | 4.10 | ... | 9.400 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | ... | trace | 24.10 | 8.40 | 22.0 | |
| Potassium bicarbonate ($KHCO_3$) | ... | ... | 51.67 | | | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 253.80 | 93.54 | 43.45 | 255.20 | 37.30 | 70.6 | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | ... | ... | 65.00 | | | | |
| Ferric oxide ($Fe_2O_3$)<br>Aluminum oxide ($Al_2O_3$) | 1.00 | 1.80 | ... | 1.80 | 1.40 | 1.6 | 2.000 |
| Sodium silicate ($Na_2SiO_3$) | ... | ... | ... | ... | ... | ... | 6.840 |
| Magnesium silicate ($MgSiO_3$) | ... | ... | ... | ... | ... | ... | 11.540 |
| Calcium silicate ($CaSiO_3$) | ... | 66.55 | ... | 66.80 | 0.90 | ... | 19.370 |
| Silica ($SiO_2$) | 44.70 | 1.46 | 9.85 | 2.00 | 37.90 | 52.8 | 24.850 |
| Total solids | 799.69 | 740.93 | 269.29 | 741.27 | 111.23 | 172.2 | 95.705 |
| Gases: | | | | | | | |
| Carbon dioxide (free), cc. per liter | 14.8 | ... | 5.4 | ... | ... | 3.2 | |
| Flow in gallons per day | 1500 | 1900 | 2448 | 10,000 | 30,100 | 200,000 | 5000 |

[1] Analyst, Dr. E. J. Lederle.
[2] Analyst, Dr. E. E. Smith.
[3] Analyst, Dr. W. P. Tonry.
[4] Dr. Emil Schlichting.

Spring No. 1, Byrd Spring, medicinal classification, weak calcic sulphated or (−CaS). This is a moderately mineralized, calcic, sulphated and bicarbonated, alkaline water, slightly carbon-dioxated, possessing diuretic, antacid and tonic properties. It is highly endorsed by the profession in the treatment of neurasthenia, hysteria, menstrual irregularities, nausea and vomiting of pregnancy and in irritations of the genito-urinary system. The waters from this spring are similar in their therapeutic properties to the celebrated Ems Kesselbrunen Spring, near Coblentz, Germany.

Spring No. 2, Goode Spring, medicinal classification, weak calcic sulphated or (−CaS). This is a moderately mineralized, calcic, sodic, sulphated and bicarbonated alkaline water, possessing diuretic, antacid and antilithic properties, and has been prescribed with success in diseases of the genito-urinary system, stone in the bladder and kidney, from uric acid, oxalates or phosphatic deposits; rheumatism and chronic joint disturbances; in diseases of the gall-bladder and catarrhal jaundice. The medicinal properties of this water are similar and possibly superior to the famous spa at Centrexville, France.

Spring No. 3, Soekahatte Spring, medicinal classification, very weak ferruginous or (− −Fe). This is a lightly mineralized, ferric, calcic, potassic bicarbonated ferruginous (aluminic) water, carbon-dioxated, possessing decided tonic and alterative properties. It carries 65 mg. of the bicarbonate of iron to the liter, and is highly recommended where an assimilable iron tonic is indicated, in anemia, chlorosis, leucocythemia, and in all depraved conditions accompanied by loss of hemoglobin from the blood stream. It is a pleasing ferruginous tonic, the most easily assimilated of all iron waters. The celebrated (steel) spring at Pyrmont, near Hanover, Germany, contains a lesser bicarbonate of iron content than Soekahatte Spring.

Spring No. 4, Poole Well, medicinal classification, weak total mineralization 2 or (−T2). This is a moderately mineralized, potassic, sodic, magnesic, muriated and calcic bicarbonated alkaline-saline water, possessing diuretic, antacid and slight aperient properties. This water has been found useful in the treatment of catarrhal conditions of the stomach and intestinal tract, biliary passages and in the milder forms of irritation of the genito-urinary tract. Excellent results have been obtained in atonic dyspepsia, hyperchlorhydria, pyrosis, water brash and distress after meals. This water in its therapeutic properties closely resembles Elizabethbrunnen Spring, a famous spa near Hamburg, Germany.

Spring No. 5, Virginia Club Spring, is a lightly mineralized, light calcic, alkaline-saline (silicious) water, possessing diuretic and slight ferruginous properties; it is well borne by the most delicate stomach, and exerts a happy effect on the gastro-intestinal tract. It approaches very closely, in amount of total solids and chemical constituents, the Poland Springs in Maine, and waters from the celebrated spa at Wildungen, Germany.

Spring No. 6, Mecklenburg Spring, is a lightly mineralized, calcic and magnesic, bicarbonated alkaline water, possessing diuretic and antacid properties, and is very similar to Spring No. 5 in its predominating chemical constituents.

Spring No. 8, Fortuna Spring, is a lightly mineralized, sodic, bicarbonated and sodic, magnesic, calcic, silicated alkaline water, possessing diuretic and antacid properties. The predominating chemical constituents are the silicates of sodium, magnesium and calcium which comprise nearly 40 per cent of the total solids, or 37.97 parts per 1,000,000. The celebrated Bagneres-De-Luchon (Lareinne) Authe-Garonne Springs in France have a silicated content of sodium, magnesium and calcium, aggregating 38.82 parts per 1,000,000. The famous Bareges (Boucheries) Hautes-Pyrenes Spring in France has a silicated content of sodium, magnesium and calcium and aluminum totaling 33.75 parts per 1,000,000. Another French spa, the Plombieres (Source Des Dames) Vosges France carries predominating amounts of the silicates of sodium, magnesium, and calcium totaling 34 per cent of the mineralization and aggregating 107 parts per 1,000,000.

Silicious waters carrying the silicates of sodium, magnesium and calcium are rare, and occur only in alkaline waters heavily charged with carbon-dioxide gas. These waters are claimed to be of value in the treatment of cancerous and other intractable skin disorders. It is claimed that they are of value in causing sugar and albumin to disappear from the urine.

The medical profession has highly endorsed these waters for the last half century. The company have on file authentic endorsements from the most eminent members of the profession, including presidents of the American Medical Association, authors of the leading text-books now used, editors of medical journals, professors in the leading medical schools, presidents of state medical societies and physicians and surgeons at the head of the leading hospitals in the country and many thousands of physicians in private practice.

The waters have been bottled and shipped for the last half century throughout the United States and even to foreign countries. The bottling plant is modern in construction and equipment. The most meticulous pains-taking care is maintained in this department to insure perfect sanitation in the handling of a medicinal water.

Besides the excellent accommodations, the unsurpassed cuisine, the luxurious baths and the celebrated curative properties of the various waters, the delightful climate and beautiful surroundings, there are many opportunities for sport and recreation: A medical director and resident staff always on hand to advise guests concerning diet, the water-cure, exercise, baths, etc. Long-distance telephone and Western Union Telegraph. (See also Chapter XV.)

## Burnett's Mineral Spring.

(*Culpeper County.*)

*Postoffice*, R.F.D. No. 3, Culpeper. *Location*, in the northeastern portion of the state; southwest of Washington City, 100 miles; north of Richmond, the capital city, 100 miles. *Situation*, in a high sandy section between the Rapidan and Rappahannock Rivers. The locality is well drained, healthy and salubrious. *Access*, via Southern Railway to Culpeper, thence 6 miles by motor to the spring. *Hotel*, no accommodations for guests nearer than the Piedmont Hotel at Culpeper. The analysis reveals the following mineralization:

BURNETT'S MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Cor. DeWeese). |
|---|---|
| Potassium chloride (KCl) | 8.3 |
| Sodium chloride (NaCl) | 82.4 |
| Magnesium chloride ($MgCl_2$) | 49.8 |
| Calcium chloride ($CaCl_2$) | 1.2 |
| Calcium sulphate ($CaSO_4$) | 74.3 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 10.2 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 144.6 |
| Ferric oxide ($Fe_2O_3$) | trace |
| Total solids | 370.8 |

Medicinal classification, weak total mineralization or (−T). This is a lightly mineralized, sodic, magnesic, muriated, calcic bicarbonated alkaline-saline water, flowing at the rate of 232 gallons in twenty-four hours, possessing diuretic, laxative and tonic properties. The water has been used with success in mild gastro-intestinal and genito-urinary affections. The water is highly esteemed by the local profession, and the whole output is distributed and consumed in the nearby localities.

## Carter's Springs.

(*Pittsylvania County.*)

*Postoffice*, Danville. *Location*, in midsouthern Virginia; south of Lynchburg, 80 miles; west of Norfolk, 220 miles; north of Burlington, N. C., 40 miles; south of Chatham, the county seat, 20 miles. *Situation*, in an open, rolling, hilly country, at an elevation of about 750 feet above sea level. *Access*, via the Southern Railway to Danville, thence by motor 3 miles west to the springs. *Hotel*, none at present, but owners advise that a modern resort hostelry is under consideration for erection in the near future. The water, on analysis, shows the following mineralization:

CARTER'S SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. H. Taylor, M.D.). |
|---|---|
| Sodium chloride ($NaCl$) | 4.29 |
| Potassium sulphate ($K_2SO_4$) | 7.13 |
| Sodium sulphate ($Na_2SO_4$) | 38.05 |
| Magnesium sulphate ($MgSO_4$) | 35.56 |
| Calcium sulphate ($CaSO_4$) | 467.85 |
| Lithium sulphate ($Li_2SO_4$) | 2.39 |
| Ferrous sulphate ($FeSO_4$) | 8.37 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 218.88 |
| Silica ($SiO_2$) | 37.96 |
| Total solids | 820.48 |

Medicinal classification, weak calcic sulphated or (−CaS). The analysis shows this to be a moderately mineralized, calcic, sulphated and bicarbonated, alkaline water, possessing diuretic, antacid, solvent and tonic properties. This water is highly endorsed in the treatment of gastric disturbance due to acidity. The sulphate radicles in solution are present in sufficient quantity to stimulate the hepatic function, increase flow of bile and liquefy the intestinal secretions and relieve mild constipation.

## Cold Sulphur Springs.

*(Rockbridge County.)*

*Postoffice*, Goshen. *Location*, in western Virginia; north of Lexington, the county seat, 25 miles; southwest of Staunton, 25 miles; east of the celebrated Virginia Hot Springs, 30 miles; west of Richmond, the capital city, 168 miles. *Situation*, in the beautiful Shenandoah Valley, near the center of the celebrated "spring region" of Virginia, so long noted for its beautiful scenery and salubrious climate. The spring issues from the side of a hill, at an elevation of about 2000 feet above sea level, overlooking this beautiful valley. *Access*, via Goshen Station, on the main line of the Chesapeake & Ohio Railway, thence a distance of 2 miles to the springs. *Hotel*, there was once a large commodious resort hostelry here, but it was burned fifteen years ago. The present owner advises that he has plans for a modern up-to-date hostelry. The analysis shows the following mineralization:

Medicinal classification, sulphuretted. The analysis shows this to be a lightly mineralized, magnesic and calcic, ferric bicarbonated and sulphated alkaline (aluminic, phosphatic) water, sulphuretted, possessing diuretic, sedative and tonic properties. If the analysis is correct it contains a large amount of sulphuretted hydrogen. The waters have been used with success in the treatment of digestive disorders, and in disorders of the liver, kidneys, etc. The water is clear and sparkling, due to the carbonic acid in solution in the water; it is pleasing to the taste and acceptable to the most delicate stomach.

COLD SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. Peter). |
|---|---|
| Lithium chloride ($LiCl$) | trace |
| Calcium chloride ($CaCl_2$) | 7.19 |
| Sodium sulphate ($Na_2SO_4$) | 11.12 |
| Magnesium sulphate ($MgSO_4$) | 9.92 |
| Calcium sulphate ($CaSO_4$) | 49.62 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 42.09 |
| Sodium phosphate ($Na_2HPO_4$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 49.50 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 50.18 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 33.81 |
| Sodium silicate ($Na_2SiO_3$) | 25.22 |
| Organic matter | 5.64 |
| Total solids | 284.20 |
| Temperature, °C. | 10 |
| Gases, cc. per liter: | |
| Hydrogen sulphide | 875 |

## Crockett Arsenic Lithia Springs.

(*Montgomery County.*)

*Postoffice*, Shawsville. *Location*, on the eastern slope of the Alleghany Mountains. *Situation*, in a beautiful gorge, surrounded by picturesque and romantic scenery, overlooking the Roanoke River, with an elevation of over 2000 feet above sea level. *Access*, via the Norfolk & Western Railway to Shawsville, thence by motor 6½ miles to the springs. *Hotel*, a substantial structure, with modern conveniences, also home-like cottages, open for the reception of patrons from June to October. The bathing establishment is fitted up with modern appurtenances for giving the famous "hot arsenic lithia baths." The waters of the Crockett Springs are very close to thermal, having a temperature of 15.6° C. to 21.2° C. (60° to 70° F.). The analysis made by the Water Division of the United States Bureau of Chemistry shows the following mineral constituents:

CROCKETT ARSENIC LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. A. Geological Survey). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.030 |
| Lithium chloride ($LiCl$) | 0.120 |
| Potassium chloride ($KCl$) | 10.530 |
| Potassium iodide ($KI$) | trace |
| Potassium sulphate ($K_2SO_4$) | 2.900 |
| Sodium sulphate ($Na_2SO_4$) | 53.300 |
| Magnesium sulphate ($MgSO_4$) | 79.200 |
| Sodium metaborate ($NaBO_2$) | trace |
| Disodium arsenate ($Na_2HAsO_4$) | 0.322 |
| Sodium nitrate ($NaNO_3$) | 0.300 |
| Sodium nitrite ($NaNO_2$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 30.000 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 232.100 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.000 |
| Calcium silicate ($CaSiO_3$) | 9.000 |
| Silica ($SiO_2$) | 43.510 |
| Total solids | 462.312 |

Medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, calcic magnesic bicarbonated and sodic magnesic sulphated alkaline-saline (arsenated) water, possessing diuretic, antacid and alterative properties. The daily flow from this spring is 6000 gallons, and is more distinguished for the variety than from the quantity of its mineral constituents; still, the constituents, though minute in quantity, are of decided therapeutic importance. The well-known physiological effects of arsenic are soon evident after taking large quantities of this water. Its action also produces alterative and tonic effects upon the system. It is said to be valuable in chronic types of skin disease characterized by scaly eruptions. In all conditions in which arsenic is indicated the waters produce the prompt physiological action of this drug, with less constitutional and local irritation than the galenical preparations of this drug.

### Dagger's Springs.

(*Botetourt County.*)

*Postoffice,* Eagle Rock, R.F.D. No. 1. *Location,* in southwestern Virginia. *Situation,* in the foothills of the Blue Ridge Mountains, at an elevation of 2000 feet above sea level, surrounded by a picturesque mountainous region. *Access,* via the James River Branch of the Chesapeake & Ohio Railway to Gala Station, thence by motor 3½ miles to the springs. *Hotel,* there is an old antiquated hotel, with some conveniences; the owner writes that there is under construction a modern up-to-date resort hotel, which will be ready for the season of 1927. This is to be an all-year-round resort, with a modern bathing establishment, fully equipped for the practice of scientific balneotherapy. The analyses on page 643 show the mineralization:

Dagger's Sulphur Spring, medicinal classification, weak alkaline, a2, weak saline −2 or (−A2, −Cl2). Chemical classification shows a moderately mineralized, sodic and calcic bicarbonated and alkaline saline water, radio-activated, sulphuretted, possessing diuretic and antacid properties.

Dagger's Chalybeate Spring, medicinal classification, weak alkaline, −a very weak ferruginous or (−Aa0.5, − −Fe), radio-activated, sulphuretted. This is a lightly mineralized ferric, calcic, magnesic, sodic bicarbonated ferruginous water possessing diuretic, antacid, tonic and reconstructive properties.

The waters from the sulphur spring have been used successfully in the treatment of disorders of the stomach and gastro-intestinal tract and in irritations of the genito-urinary tract.

The chalybeate spring has been found useful in the treatment of anemia, chlorosis and general debility. The bicarbonate of iron contained in this water, together with the manganese, makes it a valuable tonic and reconstructive.

These springs were formerly known as Dibrell's Springs, and have been open to the public continuously since 1830.

DAGGER'S SPRINGS

| Hypothetical combinations. | Parts per 1,000,000. (Analysts, Froehling and Robertson.). Dagger's Sulphur Spring. | Dagger's Chalybeate Spring. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.35 | 0.19 |
| Lithium chloride (LiCl) | trace | trace |
| Sodium chloride (NaCl) | 201.82 | 20.47 |
| Potassium iodide (KI) | 0.13 | trace |
| Potassium sulphate ($KSO_4$) | 1.19 | trace |
| Sodium sulphate ($Na_2SO_4$) | 40.45 | 18.24 |
| Calcium phosphate ($Ca_3(PO_4)_2$) | trace | trace |
| Sodium nitrate ($NaNO_3$) | 1.05 | 1.05 |
| Sodium nitrite ($NaNO_2$) | trace | trace |
| Sodium bicarbonate ($NaHCO_3$) | 263.45 | 55.54 |
| Magnesium bicarbonate ($Mg[CHO_3]_2$) | 9.22 | 28.51 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 202.46 | 77.80 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 6.65 | 54.64 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace | |
| Mangano-manganic oxide ($Mn_3O_4$) | trace | 1.40 |
| Aluminum oxide ($Al_2O_3$) | 1.00 | 1.00 |
| Silica ($SiO_2$) | 20.50 | 18.00 |
| Total solids | 829.87 | 276.94 |
| Gases: | | |
| Radio-activity, Mache units per liter | 0.13 | 0.49 |
| Sulphuretted hydrogen present in liberal amounts. | | |
| Carbon dioxide present in liberal amounts. | | |
| Flow in gallons per day | 1500 | 1200 |

## Farmville Lithia Springs.

*(Prince Edward County.)*

*Postoffice,* Farmville. *Location,* south of the central portion of the Old Dominion; west of Petersburg, 90 miles; southwest of Richmond, the capital city, 72 miles; east of Lynchburg, 55 miles. *Situation,* just west of the tidewater section in a charming little valley, at an elevation of about 600 feet above sea level. The climate here is salubrious and delightful, the air bracing and with just a tang of the pine forests in the distance. *Access,* via Farmville, on the main line of the Norfolk & Western Railway, thence only a short distance to the springs. *Hotels,* there is in course of construction at the present time a modern resort hostelry, costing in excess of $200,000, and ready October 1, 1926. There are several springs in this area, the analysis on page 644 shows the mineralization of the Farmville Lithia Spring:

Medicinal classification, weak total mineralization or (−T). The analysis shows a moderately mineralized, lithic, magnesic, calcic, ferric, bicarbonated alkaline (aluminic) water, possessing diuretic, antacid, antilithic, tonic and alterative properties. It contains a generous content of lithium bicarbonate and also of iron bicarbonate, and is abundantly charged with carbonic-acid gas. The water has long been used by the profession as a corrective in the uric-acid diathesis. It has been used with success as an antilithic in renal and cystic irritation due to stone. It is admirably indicated in gastric disturbances due

to acidity, and the iron bicarbonate content makes it a valuable tonic in anemia, chlorosis and leukocythemia and in all conditions where the hemoglobin content of the blood is below normal.

FARMVILLE LITHIA SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, E. T. Fristoe) |
|---|---|
| Sodium chloride (NaCl) | 90.68 |
| Sodium iodide (NaI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 61.42 |
| Potassium sulphate ($K_2SO_4$) | 3.23 |
| Calcium sulphate ($CaSO_4$) | 30.97 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 44.86 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 36.87 |
| Lithium bicarbonate ($LiHCO_3$) | 64.33 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 34.92 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace |
| Sulphuric acid ($H_2SO_4$) | trace |
| Aluminum oxide ($Al_2O_3$) | 43.01 |
| Silica ($SiO_2$) | 67.07 |
| Organic matter | trace |
| Total solids | 477.36 |
| Temperature, °C. | 12.2 |
| Flow in gallons per day | 1200 |

## Golindo Lithia Springs.

*(Augusta County.)*

*Postoffice*, Staunton. *Location*, in northwestern Virginia; northwest of Richmond, the capital city, 155 miles; southwest of Washington, 180 miles; north of Lynchburg, 80 miles. *Situation*, in the beautiful valley of Virginia, famous in poetry and song, for its picturesque beauty and loveliness. The Shenandoah Mountain Range rises up to the west, overlooking this spring area, which lies at an altitude of 2000 feet above sea level. *Access*, via the Baltimore & Ohio Railway. *Hotel*, no definite information available as to class of accommodations, but there are good hotels in Staunton. The analysis below shows the mineralization:

GOLINDO LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Lithium chloride (LiCl) | 0.60 |
| Potassium chloride (KCl) | 6.10 |
| Sodium chloride (NaCl) | 10.50 |
| Potassium sulphate ($K_2SO_4$) | 0.40 |
| Magnesium sulphate ($MgSO_4$) | 32.20 |
| Sodium nitrate ($NaNO_3$) | 5.85 |
| Sodium nitrite ($NaNO_2$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 133.70 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 294.30 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.40 |
| Calcium silicate ($CaSiO_3$) | 4.10 |
| Silica ($SiO_2$) | 10.10 |
| Total solids | 498.25 |
| Gases, cc. per liter: | |
| Carbon dioxide, free | 9.6 |
| Carbon dioxide set free on evaporation | 61.1 |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic, antacid and slight alterative properties. The water is said to be useful in the treatment of digestive disorders due to acidity and in irritable conditions of the renal and vesical organs. The waters are bottled and shipped.

## Holston Springs.

(*Scott County.*)

*Postoffice*, Gate City. *Location*, in the extreme southwestern corner of the state; south of Bigstone Gap, 30 miles; north of Johnson City, Tenn., 30 miles; east of Middlesboro, Ky., 65 miles; 4 miles from Gate City. *Situation*, nestling amid a wild, weird, rough and rugged, picturesque, mountainous region, on the banks of the Clinch River, at the base of Clinch Mountains, at an elevation of 1800 feet above sea level, and surrounded by the Cumberland Mountains. From all points of the compass the eye rests upon vistas of beautiful scenic grandeur. *Access*, via Gate City, on the Southern Railway, thence by motor, over splendid mountain highways, 4 miles to the springs; via Moccassin Gap, thence by motor 2 miles to the springs; and a station on the property, only a short distance from the springs; all on the Southern Railway. *Hotels*, no hotel at present, but plans are under way for the erection of a modern resort hostelry, with a bathing establishment. The springs, 4 in number, have an enormous flow, and the analysis shows the mineralization of 1 of the springs:

HOLSTON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. H. Froehling). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.059 |
| Lithium chloride (LiCl) | 0.060 |
| Potassium chloride (KCl) | 5.040 |
| Sodium chloride (NaCl) | 26.410 |
| Potassium iodide (KI) | 0.008 |
| Potassium bromide (KBr) | 0.770 |
| Sodium sulphate ($Na_2SO_4$) | 48.360 |
| Magnesium sulphate ($MgSO_4$) | 177.310 |
| Calcium sulphate ($CaSO_4$) | 194.540 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium nitrite ($NaNO_2$) | trace |
| Sodium arsenate ($Na_3AsO_4$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 315.400 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 0.790 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 5.330 |
| Aluminum oxide ($Al_2O_3$) | 0.600 |
| Silica ($SiO_2$) | 17.000 |
| Total solids | 791.677 |

Medicinal classification, weak sulphated or (−S). The analysis shows a moderately mineralized, calcic, magnesic, sulphated, bicarbonated, saline water, possessing diuretic, antacid, tonic and alterative properties, and should be of value in the treatment of digestive disorders due to acidity and in irritations of the genito-urinary tract. The waters are highly recommended in run-down, debilitated states of the system. In pathological conditions, where an iron tonic is indicated, these waters are useful, especially in anemia and chlorosis in young women and in all depraved states of the blood and blood-making organs.

### Jeffres Lithia Springs.

*(Mecklenburg County.)*

*Postoffice,* Jeffres. *Location,* in the southeastern portion of the state, not far from the North Carolina boundary line; west of Norfolk, 150 miles; east of Danville, 75 miles. *Situation,* near the eastern bank of the Roanoke River, on an eminence of some 400 feet above sea level, and overlooking this waterway. *Access,* via Clarksville, on the Keysville & Durham Division of the Southern Railway, thence a distance of 6 miles by motor to the springs. *Hotel,* no accommodations listed. The following analysis shows the mineralization of this celebrated water:

JEFFRES LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood, U. S. Dept. Agr.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.0480 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 4.2000 |
| Sodium chloride (NaCl) | 13.5000 |
| Potassium iodide (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 3.0000 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.6000 |
| Sodium nitrate ($NaNO_3$) | 3.6500 |
| Sodium nitrite ($NaNO_2$) | 0.0045 |
| Sodium bicarbonate ($NaHCO_3$) | 5.5000 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 24.7000 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 31.6000 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.2000 |
| Silica ($SiO_2$) | 47.9000 |
| Total solids | 136.8945 |

The analysis shows this to be a lightly mineralized, sodic, calcic and magnesic, bicarbonated alkaline water, possessing diuretic, antacid and slight tonic and alterative properties. This water should be of value in the treatment of gastric disorders due to acidity and in disturbances of the genito-urinary system due to mild inflammatory irritation. Its iron content imparts slight tonic properties and should be useful in the treatment of anemia and chlorosis. The waters are bottled and sold commercially.

## Massanetta Springs.

(*Rockingham County.*)

*Postoffice*, Harrisburg. *Location*, in the upper Shenandoah Valley, not far from the western boundary line of the state with West Virginia; northwest of Charlottesville, about 50 miles. *Situation*, at the foothills of the Massanetta Mountain, at an elevation of 1350 feet above sea level. *Access*, via Harrisburg, on the Southern Railway, thence over graded macadam highways, through a charming mountainous region, full of scenic views and pleasing vistas, presenting a panorama of great charm, 4½ miles to the springs. *Hotel*, a commodious and comfortable resort hostelry, with modern conveniences. The waters from Massanetta Springs have been famous for three-quarters of a century. The following analysis shows the mineralization:

MASSANETTA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Bull. No. 91, U. S. Dept. Agr.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.5490 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 2.9000 |
| Potassium bromide (KBr) | none |
| Potassium iodide (KI) | none |
| Sodium sulphate ($Na_2SO_4$) | 1.2000 |
| Potassium sulphate ($K_2SO_4$) | 3.6000 |
| Sodium nitrate ($NaNO_3$) | 3.0000 |
| Sodium nitrite ($NaNO_2$) | 0.0048 |
| Sodium bicarbonate ($NaHCO_3$) | 9.9000 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 169.8000 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 256.8000 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.5000 |
| Silica ($SiO_2$) | 12.4000 |
| Total solids | 460.6538 |
| Gases, at 0° C. and 760 mm. pressure, cc. per liter: | |
| Carbon dioxide (free) | 7.2 |
| Carbon dioxide set free from evaporation of bicarbonates | 62.8 |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic, slight antacid and tonic properties. Numerous testimonials from physicians attest the value of the water in a variety of ailments. It is reasonable, however, to believe that the excellent climatic conditions and sanitary supervision of the springs and properties add much to the attractiveness of the springs. The water is an excellent alkaline water and should act favorably in gastric and kindred disorders where an antacid water is indicated. The waters are sold commercially.

## Nye Lithia Springs.

*(Wythe County.)*

*Postoffice*, Wytheville. *Location*, in southwestern Virginia; west of Norfolk, 375 miles; south of Bluefield, W. Va., 35 miles; north of Sparta, N. C., 50 miles. *Situation*, in a cradle-like depression, on the summit of the Alleghanies, at an elevation of 2360 feet above sea level. *Access*, via Wytheville Depot, on the main line of the Norfolk & Western Railway, thence a distance of 2 miles to the springs, or via the Lee Highway, which traverses this section and comes within a short distance of the springs. *Hotel*, there are no hotel accommodations at the springs, but there is a beautiful 18-acre park shaded with primeval oak, just the setting for a resort hostelry, which is under contemplation. There are 3 springs in the area, 2 lithia and 1 chalybeate. The analyses below show the mineralization:

NYE LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, W. L. Dudley.) Spring No. 1. | (Analyst, J. L. Jarman.) Spring No. 2. |
|---|---|---|
| Potassium bicarbonate ($KHCO_3$) | ... | 0.28 |
| Sodium bicarbonate ($NaHCO_3$) | ... | 23.45 |
| Lithium bicarbonate ($LiHCO_3$) | 177.67 | 52.39 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 65.14 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 294.64 | 321.52 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 5.30 | 22.75 |
| Silica acid ($SiO_2$) | 20.36 | 11.29 |
| Total solids | 497.97 | 496.82 |
| Temperature, °C. | 12.2 | 13.3 |

Spring No. 1, medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, lithic, bicarbonated alkaline water, possessing diuretic, antacid and slight tonic properties.

Spring No. 2, medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic and lithic, bicarbonated alkaline water, possessing diuretic, antacid and tonic properties.

Both of these waters (if the analyses are correct) are high in lithium. They are highly endorsed by the profession as useful in the treatment of renal and vesical calculi, cystitis and all inflammatory conditions of the genito-urinary tract.

## Osceola Springs.

*(Rockingham County.)*

*Postoffice*, Pleasant Valley. *Location*, in northwestern Virginia; northeast of Richmond, the capital city, 165 miles; north of Lexington,

100 miles. *Situation,* in the beautiful Shenandoah Valley of Virginia, east of the Shenandoah Mountains, at an elevation of about 1500 feet above sea level. *Access,* via the Norfolk & Western Railway. *Hotel,* no definite information as to class of accommodations offered. The analysis below gives the mineralization:

OSCEOLA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.12 |
| Potassium chloride (KCl) | 3.80 |
| Sodium chloride (NaCl) | 2.40 |
| Sodium sulphate ($Na_2SO_4$) | 2.40 |
| Sodium nitrate ($NaNO_3$) | 5.47 |
| Sodium nitrite ($NaNO_2$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 14.20 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 172.20 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 213.80 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.20 |
| Silica ($SiO_2$) | 19.60 |
| Total solids | 434.19 |
| Gases, cc. per liter | |
| Carbon dioxide (free) | 38.0 |
| Carbon dioxide, set free on evaporation | 57.8 |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic and magnesic bicarbonated alkaline water, slightly carbon-dioxated, possessing diuretic, antacid and slight tonic properties. The use of this water in gastric disturbances due to acidity has been very satisfactory. It is said to be of value in bladder and kidney disorders.

## Otterburn Lithia Springs.

(*Amelia County.*)

*Postoffice,* Amelia. *Location,* in eastern Virginia; east of Roanoke, 200 miles; west of Williamsburg, 100 miles; north of the celebrated Buffalo Lithia Springs, 75 miles. *Situation,* in the western edge of tidewater Virginia, in the valley of the Appomatox River, at an elevation of about 500 feet above sea level. *Access,* via Amelia Station, on the main line of the Southern Railway, thence a short distance by motor to the springs. *Hotel,* very good hotel at Amelia, with modern accommodations. The analysis below shows the mineralization:

The analysis shows this to be a lightly mineralized, calcic, sodic, magnesic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic, antacid, tonic and alterative properties. The water is highly endorsed by local physicians as valuable in the treatment of gastric disturbances and disorders of the kidneys and bladder. The bicarbonate of iron contained in this water gives it valuable tonic properties, and it should be useful in the treatment of anemia and chlorosis and general debility.

OTTERBURN LITHIA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.2070 |
| Lithium chloride (LiCl) | 0.2800 |
| Potassium chloride (KCl) | 3.6000 |
| Sodium chloride (NaCl) | 4.3000 |
| Sodium sulphate ($Na_2SO_4$) | 4.1000 |
| Sodium metaborate ($NaBO_2$) | trace |
| Calcium phosphate ($Ca_3[PO_4]_2$) | Heavy trace |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium nitrite ($NaNO_2$) | 0.0045 |
| Sodium bicarbonate ($NaHCO_3$) | 17.5000 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 40.3000 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 82.9000 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 4.8000 |
| Silica ($SiO_2$) | 43.1000 |
| Total solids | 191.0915 |
| Gases, cc. per liter: | |
| Carbon dioxide (free) | 11.9 |
| Carbon dioxide, set free on evaporation | 20.5 |

## Powhatan Springs.

(*Powhatan County.*)

*Postoffice,* Tobaccoville. *Location,* near central Virginia; west of Richmond, the capital city, 50 miles; east of Lynchburg, 100 miles. *Situation,* in the western border of the tidewater section of the state, at an elevation of about 500 feet above sea level. *Access,* via Tobaccoville Station, on the Farmville & Powhatan Railroad, thence by motor 1 mile to the springs. *Hotel,* accommodations very primitive, but there is a good hotel at Tobaccoville. There are 2 springs, 1 lithia and 1 alum. Both show about the same mineralization, with the exception of the lithia in one and alum in the other; each has a flow of about 500 gallons per day:

POWHATAN SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.207 |
| Posassium chloride (KCl) | 2.300 |
| Sodium chloride (NaCl) | 4.300 |
| Potassium iodice (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 1.800 |
| Sodium nitrate ($NaNO_3$) | 2.120 |
| Sodium nitrite ($NaNO_2$) | 0.024 |
| Sodium bicarbonate ($NaHCO_3$) | 2.900 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 6.000 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 6.500 |
| Ferric oxide and alumina ($Fe_2O_3$,$Al_2O_3$) | 0.300 |
| Silica ($SiO_2$) | 12.000 |
| Total solids | 38.451 |
| Gases, cc. per liter: | |
| Carbon dioxide (free) | 6.70 |
| Carbon dioxide set free on evaporation | 2.20 |

The analysis shows this to be a slightly mineralized, sodic and calcic bicarbonated alkaline water, possessing antacid and slight tonic properties. The waters are bottled and shipped. They are used to some extent by physicians in the neighboring territory in the treatment of stomach disorders and in affections of the bladder and kidneys.

### Rockbridge Alum Springs.

(*Rockbridge County.*)

*Postoffice*, Rockbridge Alum Springs. *Location*, in the western part of the state; west of Richmond, 150 miles; east of Clifton Forge, 22 miles; east of Virginia Hot Springs, 35 miles; east of White Sulphur Springs, W. Va., 52 miles. *Situation*, in a deep vale, shut out from the world by Alpine hills, nestling in the fertile valley of Virginia, between the Blue Ridge and Alleghany Mountains, at an elevation of 2000 feet above sea level. This natural amphitheatre presents a panorama of superbly sublime vistas, which greet the eye from every point of the compass. The invigorating properties of the wholesome ozone from the spruce and fir trees, together with other natural advantages, make the place, with its beautiful environs, a desirable and interesting place of residence. *Access*, via Millboro Station, on the main line of Chesapeake & Ohio Railway, thence 5 miles by motor to the springs; also via motor over the best of macadam state highways. *Hotels*, there are 2 hotels and a number of cottages, offering fair accommodations. There are a number of springs, all of the aluminic sulphated acid (ferruginous) class. We give herewith an analysis of Spring No. 1:

ROCKBRIDGE ALUM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Bull. No. 91, U. S. Dept. Agr.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.514 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 2.900 |
| Sodium chloride (NaCl) | 1.200 |
| Potassium iodide (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 18.200 |
| Magnesium sulphate ($MgSO_4$) | 33.700 |
| Calcium sulphate ($CaSO_4$) | 13.900 |
| Manganous sulphate ($MnSO_4$) | 0.400 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 336.900 |
| Ferrous sulphate ($FeSO_4$) | 9.200 |
| Sodium nitrate ($NaNO_3$) | 1.820 |
| Ferric oxide ($Fe_2O_3$) | 0.400 |
| Silica ($SiO_2$) | 46.800 |
| Total solids | 459.934 |

Medicinal classification, weak acid aluminic sulphated or (−AcAlS). This is a moderately mineralized, aluminic sulphated acid (ferruginous) water, possessing styptic, tonic and alterative properties. These are the best known of the aluminic type of waters in this country. They

have been prescribed with beneficial results by the leaders of the medical profession for the past fifty years. They are indicated in every form of scrofula, ulcers, chronic diarrhea, chronic colitis and chronc dysentery, etc. The Medical Society of Virginia, in a resolution adopted, gives the Rockbridge alum waters the highest professional endorsement. For more than a hundred years these famous waters have been used at the springs and shipped to all parts of the United States. Postoffice, telegraph and long-distance telephone in the hotel.

### Rock Enon Springs.

*(Frederick County.)*

*Postoffice,* Rock Enon Springs. *Location,* in northern Virginia; northwest of Washington City, 85 miles; north of Richmond, the capital city, 175 miles. *Situation,* in the great North Mountains, about 1200 feet above sea level. *Access,* via the Shenandoah Branch of the Baltimore & Ohio Railway to Winchester, thence by motor 16 miles to the springs. *Hotel,* the old hotel, a large wooden structure, offers fair accommodation. There are several springs in this area, one of which we present the following mineralization:

ROCK ENON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Profs. Gale and New). |
|---|---|
| Sodium chloride ($NaCl$) | trace |
| Magnesium chloride ($MgCl_2$) | 19.15 |
| Magnesium sulphate ($MgSO_4$) | 220.41 |
| Calcium sulphate ($CaSO_4$) | 60.87 |
| Sodium bicarbonate ($NaHCO_3$) | 45.52 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 142.21 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 29.08 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 243.67 |
| Silica ($SiO_2$) | 7.18 |
| Aluminum oxide ($Al_2O_2$) | 13.68 |
| Total solids | 782.77 |

Medicinal classification, weak alkaline b, very weak ferruginous 3 or ($-$Ab, $--$Fe$_3$). This is a moderately mineralized, calcic, magnesic, ferruginous, bicarbonated, (alkaline-saline) water. It is somewhat similar to the celebrated Pyrmont Spring, in Waldeck, Germany. These waters have in past years attained quite an enviable reputation for their tonic and alterative properties.

### Rubino Healing Springs.

*(Bath County.)*

*Postoffice,* Healing Springs. *Location,* in the western mountainous section of Virginia; west of Richmond, the capital city, 206 miles;

west of Charlottesville, 62 miles; north of Roanoke, 80 miles. *Situation*, on the eastern slope of the Blue Ridge Mountains, in the valley of Virginia, on the head waters of the James River, at an elevation of about 2000 feet above sea level. *Access*, via the Chesapeake & Ohio Railway to Millboro, thence by motor over splendid mountain highways, through a beautiful country, a few miles to the springs. *Hotel*, no accommodations at the springs, but good hotels at Millboro. The analysis below shows the mineralization:

RUBINO HEALING SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Bull. No. 91, U. S. Dept. of Agr.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.078 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 8.200 |
| Sodium sulphate ($Na_2SO_4$) | 46.600 |
| Potassium sulphate ($K_2SO_4$) | 22.300 |
| Magnesium sulphate ($MgSO_4$) | 72.600 |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium nitrite ($NaNO_2$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 139.700 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 476.600 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.000 |
| Calcium silicate ($CaSiO_3$) | 32.900 |
| Silica ($SiO_2$) | 10.800 |
| Total solids | 811.778 |

Medicinal classification, weak alkaline b2 or (−Ab2). This is a moderately mineralized, calcic and magnesic, bicarbonated alkaline water, possessing diuretic, antacid and slight laxative and tonic properties. This water should be useful in digestive disturbances due to acidity and also in irritable conditions of the kidneys and bladder. The sulphate radicles are present in sufficient amount to exert laxative action. The waters are bottled and shipped extensively throughout this and adjoining states.

## Seawright Springs.

(*Augusta County.*)

*Postoffice*, Staunton. *Location*, northwestern Virginia; northwest of Richmond, the capital city, 150 miles; southwest of Washington City, 175 miles. *Situation*, in the picturesque Shenandoah Valley, close to the eastern foothills of the Alleghany Mountains, at an altitude of about 2000 feet above sea level. *Access*, via the Baltimore & Ohio Railway. *Hotel*, the information is meager, but there are good hotels in Staunton. The waters are bottled and shipped extensively. The following analysis shows the mineralization.

SEAWRIGHT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, H. Froehling). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.075 |
| Potassium chloride (KCl) | trace |
| Sodium chloride (NaCl) | 7.230 |
| Potassium bromide (KBr) | trace |
| Potassium sulphate ($K_2SO_4$) | 8.240 |
| Sodium sulphate ($Na_2SO_4$) | 2.800 |
| Sodium nitrate ($NaNO_3$) | 3.470 |
| Sodium bicarbonate ($NaHCO_3$) | 14.490 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 182.760 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 264.010 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.930 |
| Aluminum oxide ($Al_2O_3$) | 1.750 |
| Silica ($SiO_2$) | 8.760 |
| Total solids | 495.515 |
| Gases, cc. per liter: | |
| Carbon dioxide (free) | 540 |
| Carbon dioxide set free on evaporation | 183 |

Medicinal classification, weak alkaline b or (−Ab), carbon-dioxated. This is a moderately mineralized, sodic, calcic, magnesic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic, antacid and tonic properties. The use of this water medicinally goes back almost a century. It has the highest endorsement from many eminent physicians, who recommend its use in bladder and kidney troubles, in Bright's disease, renal and vesical calculi, diabetes, stomach, intestinal, liver and biliary disorders. It has also been used with success in the treatment of rheumatism, arthritis, gout and the uric-acid diathesis.

## Shenandoah Alum Springs.

(*Shenandoah County.*)

*Postoffice,* Shenandoah Alum Springs. *Location,* in northern Virginia; northwest of Richmond, the capital city, 160 miles; west of Washington City, 155 miles. *Situation,* in the upper portion of the beautiful valley of the Shenandoah, near the north fork of the Shenandoah River, nestling at the foot of North Mountain, at an elevation of about 2000 feet above sea level. The grounds surrounding the tavern slope toward the east and permits the sun to flood the place with light and warmth. *Access,* via Mt. Jackson, a station on the Southern Railway, thence a distance of 12 miles to the springs. *Hotel,* the tavern is a commodious resort; the accommodations are comfortable, but not luxurious. There is no bathing establishment. The waters, on analysis, show the following mineralization:

SHENANDOAH ALUM SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. J. W. Mallet). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 2.10 |
| Lithium chloride (LiCl) | 0.52 |
| Potassium chloride (KCl) | 2.42 |
| Sodium chloride (NaCl) | 8.68 |
| Potassium iodide (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 48.62 |
| Magnesium sulphate ($MgSO_4$) | 59.74 |
| Calcium sulphate ($CaSO_4$) | 86.28 |
| Manganese sulphate ($MnSO_4$) | 6.52 |
| Cupric sulphate ($CuSO_4$) | 1.93 |
| Ammonium sulphate ($[NH_4]_2SO_4$) | 2.94 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 591.60 |
| Ferrous sulphate ($FeSO_4$) | 141.60 |
| Ferric oxide ($Fe_2O_3$) | 0.85 |
| Nitric acid ($HNO_3$) | 0.82 |
| Silica ($SiO_2$) | 83.01 |
| Total solids | 1037.63 |

Medicinal classification, weak acid aluminic ferrous sulphated 3, very weak ferruginous 2 or (−AcAlFeS3, −−Fe2). This is a moderately mineralized, aluminic, ferruginous, sulphated acid water, possessing diuretic, astringent, alterative, tonic and restorative properties, and if taken in large quantities the sulphate ions stimulate intestinal activity and thereby exert slight laxative action. The waters have been highly endorsed in the treatment of chronic diarrhea, dysentery and colitis. The iron content gives it decided tonic action and indicates its use in anemia, chlorosis and wherever an iron tonic is needed.

## Stribbling Springs.

(*Augusta County.*)

*Postoffice,* Stribbling Springs. *Location,* in western Virginia; west of Washington City, 156 miles; northwest of Richmond, the capital city, 136 miles; east of Cincinnati, O., 339 miles; east of Huntington, W. Va., 156 miles. *Situation,* in the beautiful Shenandoah Valley, at the eastern foothills of the Shenandoah Mountains, at an elevation of about 200 feet above sea level. *Access,* via the Chesapeake & Ohio Railway to Staunton, thence by motor 13 miles to the springs; by motor over the great national highways to the springs. *Hotel,* this is an old-fashioned resort hostelry. The springs, sometimes called Augusta Springs, comprise 3 alum springs and 2 chalybeate springs and 1 lithia spring. The analysis of the latter we present herewith:

STRIBBLING SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.063 |
| Lithium chloride (LiCl) | 0.300 |
| Potassium chloride (KCl) | 2.500 |
| Sodium chloride (NaCl) | 0.700 |
| Potassium iodide (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 3.000 |
| Sodium metaborate ($NaBO_2$) | trace |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 10.200 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 8.400 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 15.800 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.600 |
| Silica ($SiO_3$) | 20.100 |
| Total solids | 62.663 |
| Gases, cc. per liter: | |
| Carbon dioxide (free) | 2.2 |

This is a slightly mineralized, sodic and calcic bicarbonated alkaline water, possessing diuretic, tonic and antilithic properties. The water is of value in the treatment of digestive disturbances, bladder and kidney irritations, anemia and run-down conditions, general debility, etc.

## Virginia Etna Springs.

*(Roanoke County.)*

*Postoffice*, Vinton. *Location*, in the western part of the state; west of Lynchburg, 60 miles; southwest of Charlottesville, 100 miles. *Situation*, under the shadows of the outlying ranges of the Alleghanies, in a high and dry mountainous region, of some 2000 feet elevation. *Access*, via the depot at Vinton, on the Norfolk & Western Railway, thence a distance of 1000 feet to the springs. *Hotel*, no accommodations for guests, but there are good hotels in Roanoke. The analysis of the water shows the following mineralization:

VIRGINIA ETNA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Stillwell & Gladding). |
|---|---|
| Sodium chloride (NaCl) | 9.50 |
| Potassium sulphate ($K_2SO_4$) | 4.98 |
| Sodium sulphate ($Na_2SO_4$) | 8.56 |
| Calcium sulphate ($CaSO_4$) | 232.88 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Lithium bicarbonate ($LiHCO_3$) | 1.10 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 72.90 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 162.28 |
| Ferrous bicarbonate ($Fe[HCO_4]_2$) | trace |
| Aluminum oxide ($Hl_2O_3$) | 3.28 |
| Silica ($SiO_2$) | 21.13 |
| Total solids | 516.61 |
| Gases, cc. per liter: | |
| Carbon dioxide (free) | 3.7 |
| Oxygen, cc. per liter | 4.6 |
| Flow in gallons per day | 16,000 |

Medicinal classification, weak total mineralization or (−T). The analysis shows this to be a moderately mineralized, calcic, sulphated and bicarbonated alkaline water, possessing diuretic, antacid, solvent and slight tonic properties. This water is useful in the treatment of irritable disorders of the genito-urinary tract and in disturbances of the digestive tract due to acidity. The waters are bottled and shipped commercially. The bottling plant is modern in construction and equipment.

### Virginia Hot Springs.

(*Bath County.*)

*Postoffice*, Hot Springs. *Location*, in midwestern Virginia; west of Richmond, the capital city, 225 miles; north of Danville, 140 miles; north of Covington, the county seat, 20 miles; southwest from Washington City, 315 miles; south of Pittsburgh, Pa., 240 miles; east of Huntington, W. Va., 225 miles; east of Cincinnati, O., 275 miles. *Situation*, in a beautiful valley, lying in the heart of the Appalachian Mountains, in the first of several lofty ranges that lie east of and parallel with the Alleghany Divide. This valley is some 2 miles wide and about 12 miles in length, nestling between towering ranges, from the crests of which, 4000 feet above sea level, villages and farm residences with intervening spaces stretch out 1500 feet below, into a beautifully picturesque panorama of constantly changing landscapes of great scenic beauty and grandeur. Far off in the dim and distant horizon loom up peaks of wonderful grandeur, Flag Rock and Elliott's Knob, one of the highest peaks in the state, rises up to meet the horizon; near Lexington is viewed the pinnacle of House Mountains and the celebrated Twin Peaks of Otter. The scenery of this beautiful valley is richly colored, presenting scenic vistas of great grandeur. *Access*, via the Hot Springs Branch of the Chesapeake & Ohio Railway; through sleepers each day from the North, Boston, New York, Philadelphia, Washington; from the South, through connections from Jacksonville, Savannah, Charleston; from the West, Kansas City, Chicago and Indianapolis, etc.; by motor over the splendid national highways, which traverse this section. *Hotel*, the hotel is of pleasing architectural design, brick, steel and concrete construction, containing more than 500 guest chambers, many of which are *en suite*. The furnishings are luxurious, the decorations ornate. The cuisine is unexcelled and the service faultless. The bathing establishment is of modern construction, fitted with the latest and most approved equipment for the scientific application of the latest knowledge in hydriatics, directed by an eminent physician, well versed in hydrology, with a competent medical staff and a corps of trained assistants. The bath-house is connected with the hotel by an ornate viaduct, through which the bather can reach the baths from his room in the hotel without outside exposure. On the upper floor of the bathing

building is a very large solarium, luxuriously furnished, where bathers can rest after bathing; here will be found every appointment for convenience and comfort. In addition to the thermal bathing establishment, the physiotherapy department is fitted with every known apparatus for the treatment of suitable cases. There is a complete Zander Institute for Swedish gymnastics, massage, hot-air treatments, etc.

The Hot Springs and their medicinal virtues have been known to the white man for four generations, and as far back as 1838, when the nearest railway station was Philadelphia and the means of transportation from there to the springs were pack horses and stage coach; the records show that 6000 guests were entertained, the majority coming from the New England States. In the early days, as well as at the present, the elite of society have sojourned here as pleasure-loving, health-seeking guests; their children and their children's children continue to come. The climate is delightful and salubrious, agreeable mornings, cloudless skies, balmy noon and glorious sunsets; the atmosphere is stimulating and invigorating. The Virginia Hot Springs have the distinction of being one of only three localities east of the Rocky Mountains where thermic waters are found. The analyses below show the mineralization of a few of the springs:

VIRGINIA HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, F. W. Clarke). | | | | | |
|---|---|---|---|---|---|---|
| | Boiler Bath Spring. | Hot Spout Bath Spring. | Octagon Bath Spring. | New Hot Spring. | Sulphur Bath Spring. | Magnesian Spring. |
| Potassium bromide (KBr) | trace | trace | none | none | none | none |
| Potassium chloride (KCl) | 10.5 | 9.2 | 8.6 | 6.1 | 6.8 | 4.2 |
| Potassium sulphate ($K_2SO_4$) | 13.8 | 18.7 | 18.5 | 21.1 | 15.8 | 10.9 |
| Sodium sulphate ($Na_2SO_4$) | 37.0 | 28.1 | 29.6 | 27.8 | 42.0 | 20.1 |
| Calcium sulphate ($CaSO_4$) | 140.7 | 142.4 | 150.4 | 140.1 | 127.8 | 74.4 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 212.3 | 194.6 | 197.3 | 198.9 | 177.1 | 118.4 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 381.5 | 387.2 | 379.1 | 368.1 | 381.5 | 298.9 |
| Aluminum oxide ($Al_2O_3$) | 2.0 | 2.5 | 3.5 | 6.0 | 6.5 | |
| Silica ($SiO_2$) | 27.5 | 23.5 | 25.5 | 23.5 | 23.0 | 12.6 |
| Loss | 5.6 | 9.0 | 2.1 | ... | 4.6 | 3.3 |
| Total solids | 830.9 | 815.2 | 814.6 | 791.6 | 785.1 | 542.2 |
| Temperature, °C. | 40.6 | 41.1 | 36.7 | 35.4 | 37.7 | 359 |
| Radio-activity, Mache units per liter | 86.54 | 16.55 | 4.88 | ... | 101.87 | 260.5 |

Boiler Bath Spring, medicinal classification, weak alkaline b2 or (−Ab2), thermic, strong radio-activated.

Hot Spout Bath Spring, medicinal classification, weak alkaline b2 or (−Ab2), thermic, radio-activated.

There is such a marked similarity in the percentage of the predominating chemical constituents of the Boiler Bath and the Hot Spout Bath Springs that they will be classed together as moderately mineralized, thermic, calcic and magnesic, bicarbonated and sulphated, alkaline waters, carbon-dioxated and strong radio-activated.

Octagon Bath Spring, Medicinal classification, weak alkaline b2 or (−Ab2), thermic, weak radio-activated.

New Hot Spring, medicinal classification, weak alkaline b2 or (−Ab2), thermic.

Sulphur Bath Spring, medicinal classification, weak alkaline b or (Ab), thermic, strong radio-activated.

The Octagon Bath, New Hot and Sulphur Bath Springs are also similar in the percentage of their predominating chemical constituents, and are classed as moderately mineralized, thermic, calcic, magnesic, bicarbonated and sulphated, alkaline waters, carbon-dioxated; the Sulphur Bath Springs, sulphuretted, radio-activated.

Magnesian Spring, medicinal classification, weak alkaline b or (−Ab), thermic, very strong radio-activated. This is a moderately mineralized, thermic, calcic and magnesic bicarbonated alkaline water, carbon-dioxated, radio-activated.

These waters are highly endorsed as efficacious in the treatment of a great variety of diseased conditions which afflict humanity. Their employment has given relief in gout, rheumatism, rheumatic gout, obesity, sciatic neurasthenia, nervous prostration, locomotor ataxia, old joint injuries and disturbances of digestion due to acidity and hyperacidity, diseases of the liver and disorders peculiar to women. The Virginia Hot Springs are all heavily charged with radio-active emanations, which add greatly to their therapeutic potency in the treatment of many diseased conditions. These waters closely resemble in chemical composition those of the celebrated Hot Springs in Arkansas. They also are quite similar to those of Aix-les-Bains, in France, though the French spring has a slightly higher temperature. Both for internal use and for bathing the waters of Virginia Hot Springs have gained a wide celebrity in the treatment of a wide range of diseased conditions. The thermic waters and the elaborate methods of using them internally and in the bathing establishment make this one of the greatest spas in the world. Here can be had every advantage of treatment that can be secured at any of the greater spas in the Old World.

Besides the metropolitan conveniences of the hotel and the efficatious advantages of the bathing establishment, the delightful social intercourse, beautiful scenery and delightful surroundings, there are many attractions to those who are inclined to athletics—there are 2 wonderful golf courses, a number of tennis courts and the stable has 200 Kentucky thoroughbred saddle horses for those who enjoy horseback riding. Everything here for comfort, enjoyment, luxury and health-building. (See also Chapter XV.)

## Healing Springs.

*(Bath County.)*

*Postoffice*, Healing Springs. *Location* and *Situation*, same as for Virginia Hot Springs. *Access*, via Hot Springs Station, thence by motor 3 miles to the springs. There is direct telephone connections with the Hot Springs Depot and the hotel at the Virginia Hot Springs, which own and operate Healing Springs as a summer resort; open May 1 to September 15. *Hotel*, accommodations are modern, comfortable and enjoyable. Splendid bathing accommodations, all conveniences. There are 2 springs in this area which have been analyzed, and, as will be seen, the waters are almost identical with those of Schlangenbad and Ems in Germany.

HEALING SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. W. E. Aiken). | |
|---|---|---|
| | Old Spring. | New Spring. |
| Potassium chloride (KCl) | trace | 4.28 |
| Sodium chloride (NaCl) | 4.82 | 4.96 |
| Sodium iodide (NaI) | trace | trace |
| Sodium bromide (NaBr) | trace | trace |
| Potassium sulphate ($K_2SO_4$) | 37.81 | 43.28 |
| Magnesium sulphate ($MgSO_4$) | 124.04 | 126.44 |
| Ferrous sulphate ($FeSO_4$) | 3.08 | 1.71 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 3.93 | 3.93 |
| Calcium sulphate ($CaSO_4$) | 22.58 | 21.56 |
| Potassium bicarbonate ($KHCO_3$) | 6.65 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 34.37 | 54.33 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 496.26 | 518.88 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 1.94 | 7.76 |
| Crenic acid | 14.71 | 15.05 |
| Silicic acid ($SiO_3$) | 32.34 | 31.14 |
| Total solids | 782.53 | 833.32 |
| Temperature, °C. | 30 | 32 |
| Gases: | | |
| Carbon dioxide | 37.64 | 39.18 |
| Hydrogen sulphide | trace | trace |

Old Spring and New Spring, medicinal classification, weak alkaline b or (−Ab). The percentage of the predominating chemical constituents are so close, and the amount of total solids so similar, that we may class both of these springs as moderately mineralized, calcic, magnesic, bicarbonated and sulphated alkaline-saline water, carbon-dioxated, sulphuretted, possessing diuretic, slight laxative, tonic and alterative properties. These waters have been popular for more than a century, and have been used with success in irritable conditions of the renal and vesical organs, chronic congestion of the liver, in the milder forms of Bright's disease and as a tonic in debilitated states generally. These

waters are valuable where an iron tonic is indicated, such as chlorotic anemia of young girls just budding into womanhood.

## Wallawhatoola Springs.

*(Bath County.)*

*Postoffice,* Millboro Springs. *Location,* in western Virginia; west of Richmond, the capital city, 175 miles; east of the celebrated Hot Springs, 25 miles. *Situation,* in the beautiful valley of Virginia, with the Blue Ridge Mountains on the east and the Alleghany Mountains on the west; the springs and cottages are situated on a sloping eminence, about 2000 feet above sea level. *Access,* via Millboro Station, on the main line of the Chesapeake & Ohio Railway; through trains east and west daily; via the national highways, which traverse this section; beautiful scenic roads, full of attractive charm. *Hotel,* the cottages and a large establishment, a camp for boys, offer good accommodations. The analysis below shows the mineralization:

WALLAWHATOOLA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. F. Chandler). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.0770 |
| Lithium chloride (LiCl) | 1.2000 |
| Potassium chloride (KCl) | 4.4000 |
| Sodium chloride (NaCl) | 0.7000 |
| Potassium iodide (KI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 29.3000 |
| Magnesium sulphate ($MgSO_4$) | 68.3000 |
| Calcium sulphate ($CaSO_4$) | 7.9000 |
| Ferrous sulphate ($FeSO_4$) | 7.9000 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 286.9000 |
| Manganous sulphate ($MnSO_4$) | 6.9000 |
| Sodium nitrate ($NaNO_3$) | 4.8500 |
| Sodium nitrite ($NaNO_2$) | 0.0036 |
| Calcium silicate ($CaSiO_3$) | 26.5000 |
| Silica ($SiO_2$) | 55.3000 |
| Total solids | 500.2306 |

Medicinal classification, weak acid aluminic sulphated or (−AcAlS). This is a moderately mineralized, aluminic sulphated, acid water, possessing astringent and tonic properties. This water has been used for seventy years, and has the highest endorsements from the profession in the treatment of chronic dysentery and chronic colitis, etc. This water is said to be useful as an adjunct to the treatment of neurasthenia and other chronic nervous disorders, as well as in chronic inflammations of the female pelvis, prostatic enlargement in elderly men and in chronic cystic disorders. The waters are bottled and shipped extensively.

## Wyrick Mineral Springs.

*(Wythe County.)*

*Postoffice*, Crockett. *Location*, in western Virginia; southwest of Richmond, the capital city, 300 miles; southwest of Roanoke, 100 miles; north of Sparta, N. C., 35 miles; south of Bluefield, W. Va., 35 miles. *Situation*, at the base of a mighty cliff, on the crest of the Blue Ridge Divide, in the heart of the Alleghany Mountains, at an altitude of 2387 feet above sea level. *Access*, via the Norfolk & Western Railway. *Hotel*, the Wyrick Inn sits on the slope of the wooded hill to the right of the spring some 200 feet; open throughout the year. This is an inn of modern structure, fitted with all modern conveniences. The cuisine is excellent; the service good. The bathing establishment connected with the inn is modern in construction and equipment; here the latest technic in hydrotherapy and balneotherapy is scientifically administered under the supervision of an eminent physician. The inn has all the latest appointments, electric lights, steam heat, refrigerating service, etc. The water has the following mineralization, as shown by analysis below:

WYRICK MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, H. C. Fuller). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Sodium chloride (NaCl) | 1.8 |
| Potassium sulphate ($K_2SO_4$) | 6.0 |
| Sodium bicarbonate ($NaHCO_3$) | 35.4 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 32.7 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 97.2 |
| Ferric oxide and alumina ($FeO_3$, $Al_2O_3$) | 4.2 |
| Silica ($SiO_2$) | 8.4 |
| Total solids | 185.7 |

The analysis shows this to be a lightly mineralized, calcic, magnesic, sodic, bicarbonated, alkaline water, possessing diuretic, antacid and slight tonic properties. The waters are highly endorsed by the profession in gastric disorders due to acidity and hyperacidity in hepatic disorders and in bladder and kidney affections. The waters are bottled and shipped extensively throughout this and adjoining states. Wyrick Mineral Springs water has proven to be highly beneficial in the relief of many diseases, especially those created by toxic conditions of the blood, giving rise to distressing, debilitating and oftentimes serious and dangerous ailments when allowed to have their sway unchecked. Indigestion, dyspepsia, gastritis, rheumatism, eczema, kidneys, bladder and liver troubles, Bright's disease, diabetes, stomach troubles, sciatica, gall-stones, uric-acid poisoning, nervousness and insomnia. (See also Chapter XV.)

The following springs were used as resorts:

*Antidyspeptic and Tonic Springs, P. O.*, Burkeville, Nottoway County. Location, 1½ mile from Burkeville. The altitude is 530 feet above sea level. There are 2 springs in the area. Small hotel and boarding house. No definite information nor satisfactory analysis available.

*Burner's Springs, P. O.*, Woodstock, Shenandoah County. Location, in the beautiful Shenandoah Valley, at an elevation of 1500 feet above sea level. There are 7 springs in the area and from this fact the place is sometimes called Seven Fountains. No definite information nor satisfactory analysis available.

*Clayford Chalybeate Springs, P. O.*, Burke's Garden, Tazewell County. Located in a mountainous region 12 miles from Tazewell, at an elevation of 3100 feet above sea level. The Grossclose Inn offers accommodations. No definite information nor satisfactory analysis available.

*Colemanville Mineral Springs, P. O.*, Lucyville, Cumberland County. This spring at one time gave promise of becoming a vigorous rival to some of the older Virginia spas. There are some 20 springs in the area. No definite information nor satisfactory analysis available.

*Dagger's Springs, P. O.*, Botetourt County. Location, in the foothills of the Blue Ridge Mountains. No definite information nor satisfactory analysis available. (Later: information received, page 642.)

*Farquier White Sulphur Springs, P. O.*, Fauquier White Sulphur Springs, Fauquier County. Location in the foothills of the Blue Ridge Mountains, at an elevation of 1000 feet above sea level. As early as 1834 these springs were coming into prominence, and two large hotels and a number of cottages capable of accommodating 1000 guests were built. The correspondence failed to elicit any definite information or satisfactory analysis.

*Glenola Springs, P. O.*, Jennings Ordinary, Nottoway County. This was formerly known as Wayland Springs. The location is about 500 feet above sea level. The water is a light iodic, alkaline bicarbonated. No definite information nor satisfactory analysis available.

*Hubbard Springs, P. O.*, Jonesville, Lee County. Location, in southwest Virginia, at the foothills of the Cumberland Mountains, at an elevation of 1450 feet above sea level. There are 4 springs in the area. No definite information nor satisfactory analysis available.

*Huguenot Springs, P. O.*, Mosely, Powhatan County. The location is 16½ miles from Richmond and 2 miles from Vinta Station, on the Chesapeake & Ohio Railway; 2½ miles from Dry Bridge, on the Southern Railway. There are 2 springs in this area, 1 sulphur and 1 iron. Huguenot Spring has been known as a health resort for more than one hundred years. There was at one time a very large hotel, which was popular as a summer resort for the best families of the community. There are many places of historic interest nearby. No definite information nor satisfactory analysis available.

*Hunter's Pulaski Alum Springs, P. O.*, Sassin, Pulaski County. Located $8\frac{1}{2}$ miles north of Pulaski City. The elevation is 2000 feet above sea level. Hotels and cottages. No definite information nor satisfactory analysis available.

*Iron Lithia Springs, P. O.*, Tazewell, Tazewell County. Location, in the Alleghany Mountains, at an elevation of 2700 feet above sea level. There are 5 springs in the area. The waters are said to contain considerable quantity of manganese, but no definite information nor satisfactory analysis available.

*Jordan's White Sulphur Springs, P. O.*, Jordan's Springs, Frederick County. Location, in the beautiful Shenandoah Valley, at an elevation of 1200 feet above sea level. A good resort hostelry furnishes accommodations. No definite information nor satisfactory analysis available.

*Millboro Springs, P. O.*, Millboro, Bath County. Location, near the foothills of the Alleghany Mountains, at an elevation of 2000 feet above sea level. Hotel and sanitarium, with a capacity for 1000 guests. Repeated correspondence failed to elicit any definite information or satisfactory analysis.

*Montgomery White Sulphur Springs, P. O.*, Montgomery Springs, Montgomery County. This attractive summer resort is located in the Alleghany Mountains, at an elevation of 2000 feet above sea level. Twenty-one miles distant is the celebrated Mountain Lake, the next highest point in Virginia, having an elevation of more than 4800 feet. Hotels and cottages.

*Rawley Springs, P. O.*, Rawley Springs, Rockingham County. This famous Virginia resort is located in a mountainous region, 2000 feet above sea level. Hotels and cottages offer accommodations for 150 guests. No definite information nor satisfactory analysis available.

*Roanoke Red Sulphur Springs, P. O.*, Roanoke Red Sulphur Springs, Roanoke County. Located in the shadows of the Alleghany Mountains, 12 miles from Roanoke City. Hotels and cottages.

*Seven Springs, P. O.*, Glade Springs, Washington County. The waters are said to be heavily charged with iron and alum, with a considerable quantity of magnesium and calcium sulphate. No definite information nor satisfactory analysis available.

*Sweet Chalybeate Springs, P. O.*, Sweet Chalybeate Springs, Alleghany County. Location, in the Alleghany Mountains, at an altitude of 3000 feet above sea level, in the midst of the celebrated Virginia Spring region.

*Talley's Springs, P. O.*, Palmer's Springs, Mecklenburg County. Location, in eastern Virginia, at an elevation of about 500 feet above sea level. No definite information nor satisfactory analysis available.

*Washington Springs, P. O.*, Glade Springs, Washington County. Location, near White Top Mountains, one of the highest peaks in Virginia, at an elevation of 2250 feet above sea level. There are several springs in the area. No definite information nor satisfactory analysis available.

*Yellow Sulphur Springs, P. O.*, Yellow Sulphur Springs, Montgomery County. Located near the summit of the Alleghany Mountains, at an elevation of 2000 feet above sea level. Hotels and cottages. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Alkaline Lithia Springs, P. O.*, Staunton, Augusta County.
*Beaufont Mineral Springs, P. O.*, Richmond, Henrico County.
*Blue Ridge Springs, P. O.*, Blue Ridge Springs, Rotetourt County.
*Broad Rock Springs, P. O.*, Richmond, Henrico County.
*Calcic Mineral Springs, P. O.*, Norfolk, Norfolk County.
*Carper Lithia Springs, P. O.*, East Radford, Montgomery County.
*Craig Healing Springs, P. O.*, Craig Healing Springs, Craig County.
*Crystal Spring, P. O.*, Ivy Depot, Albemarle County.
*Fonticello Spring, P. O.*, Richmond, Henrico County.
*Green Springs, P. O.*, Trevilians, Louisa County.
*Holly Hill Spring, P. O.*, Charlottesville, Albemarle County.
*Lithia Magnesia Springs, P. O.*, Rocky Mount, Virginia.
*Mecklenburg Spring, P. O.*, Chase City, Mecklenburg County.
*Mico Mineral Well, P. O.*, Alexandria, Alexandria County.
*Panacea Springs, P. O.*, Drawer 48, Hopewell, Prince George County.
*Pickett's Radio-active Springs, P. O.*, Farmville, Prince Edward County.

## WASHINGTON.

Washington extends from 45°33′ to 49° north latitude and from 117° to 121°41′ west longitude, and comprises an area of 69,180 square miles, of which 2300 square miles are covered by water. The state is roughly rectangular in shape, with an extreme length from east to west of 360 miles and an extreme breadth from north to south of 240 miles. The state is divided into two unequal sections by the Cascade Mountains, which form a lofty plateau, falling steeply on both sides, and eroded into a rugged complex of peaks and ridges, nearly 100 miles wide. The main crest has an average altitude of about 5000 feet, but from the southern part of the plateau the three great volcanic cones, Mount Ranier, which bears a number of glaciers, Mount Adams and Mount St. Helen, rise respectively to altitudes of 14,526, 12,470 and 10,000 feet. The Coast Range is a spur from the Cascades, its highest elevation being Mt. Olympus, 8000 feet. These mountains are covered with immense forests of fir, spruce, cedar and pine, through which the Columbia River, noted for its grand and awe-inspiring scenery, flows the entire length of the state. The principal topographical feature of the state is the great Puget Sound, one of the most beautiful sheets of water in the world, covering an area of 2000 square miles. The climate in western Washington is equable, with a mean temperature for January of 3.11° C. (39° F.) and for July of 16.7° C. (62° F.), while the minimum is between −12.2° and −27.7° C.

(10° and 22° F., below zero), and the maximum about 34.1° C. (95° F.); in eastern Washington the mean temperature for January is 1.1° C. (30° F.) and for July 23.3° C. (74° F.), while the extremes range between (−44.4° and −34.4° C. (48° and 30° F. below zero).

Washington has been credited with 15 spring localities, with 19 individual springs, of which 1 has been analyzed and 2 used as resorts. Walton mentions 1 locality, Crook gives 3 and Peale 2. The number of springs in Washington is very small, and so far as known of little importance. The few analyses made show sulphuretted and saline waters.

### Blockhouse Mineral Springs.

*(Klickitat County.)*

*Postoffice,* Blockhouse. *Location,* in midsouthern Washington; east of Vancouver, 100 miles; west of Walla Walla, 120 miles. *Situation,* in a pleasing valley, through which runs a turbulent mountain stream, that dashes through canyons at an elevation of about 600 feet above sea level. Mount Adams lies to the northwest, its pinnacle piercing the clouds at an altitude of 12,470 feet above tidewater. *Access,* via Spokane, Portland & Seattle Branch of the Southern Pacific Railways, thence by motor 7 miles to the springs. *Hotel,* a 3-story structure, with spacious halls, broad verandas, large, airy, well-ventilated chambers, splendid menu and good service. The spring shows the following analysis:

BLOCKHOUSE MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Wells & Co.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 1.5 |
| Sodium chloride (NaCl) | 12.5 |
| Potassium sulphate ($K_2SO_4$) | 2.8 |
| Sodium sulphate ($Na_2SO_4$) | 13.1 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 187.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 148.4 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 34.8 |
| Silica ($SkO_2$) | 84.6 |
| Total solids | 485.3 |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, magnesic, calcic, bicarbonated alkaline water, possessing diuretic, antacid and tonic properties. The water is said to be useful in the relief of distressing symptoms attending gastric digestive disturbances due to acidity and for the relief of irritable conditions of the bladder and kidneys. Amusements, motoring, mountain climbing, fishing, dancing, music, etc.

## Klickitat Mineral Springs.

(*Klickitat County.*)

*Postoffice*, Klickitat. *Location*, in southern Washington; west of Walla Walla, 120 miles; east of Vancouver, 80 miles. *Situation*, on the foothills of the outlying spurs of Mt. Adams, about 600 feet above sea level in the valley of the turbulent Klickitat River, which dashes through glaciers, mute sentinels of the great volcanic disturbance which once shook this mightly rock-ribbed area. *Access*, via the Goldendale Branch of the Southern Pacific & Sacramento Railway. *Hotel*, no definite information concerning character of accommodations. The springs issue from the rock-bound strata of the foothills of Mt. Adams and bubbles forth in all its purity from the laboratory of Mother Nature. The analysis below shows the mineralization of Springs 2 and 3.

KLICKITAT MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, L. V. Hempton). Spring No. 2. | Spring No. 3. |
|---|---|---|
| Ammonium chloride ($NH_4Cl$) | trace | trace |
| Potassium chloride (KCl) | 116.35 | 170.65 |
| Sodium chloride (NaCl) | 147.23 | |
| Magnesium chloride ($MgCl_2$) | 38.64 | 516.07 |
| Sodium bicarbonate ($NaHCO_3$) | 717.73 | 205.82 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 226.04 | 337.13 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.51 | 0.34 |
| Silica ($SiO_2$) | 3.59 | 2.22 |
| Total solids | 1250.09 | 1232.23 |
| Gases: | | |
| Carbon dioxide (free), cc. per liter | 97.2 | 139.8 |

Spring No. 2, medicinal classification, weak alkaline a2 or (−Aa2). This is a moderately mineralized, sodic, magnesic bicarbonated and muriated alkaline-saline water, possessing diuretic and antacid properties.

Spring No. 3, medicinal classification, weak alkaline ab, weak saline 2 or (−Ab2, −Cl 2) carbon-dioxated. This is a moderately mineralized, magnesic muriated and bicarbonated alkaline-saline (potassic) water, carbon-dioxated, possessing diuretic, antacid and alterative properties.

These waters are highly endorsed by the profession of this and adjoining states in the treatment of non-organic stomach troubles and in disorders of the kidneys and bladder. The waters are bottled and shipped extensively.

## Medical Lake.

(*Spokane County.*)

*Postoffice*, Medical Lake. *Location*, in eastern Washington; east of Seattle, 320 miles; north of Colfax, 60 miles; south of Colville, 70

miles; west of Spokane, the county seat, 18 miles. *Situation*, this lake, 1½ miles in length by ½ mile in width, is situated on a plateau, at an elevation of about 5000 feet above sea level. *Access*, via the Central Washington Branch of the Northern Pacific Railway, thence by motor 8 miles to the lake. *Hotel*, there are a number of hotels and commodious bath-houses surrounding the lake. The accommodations are modern, every convenience from simple service to luxury. The waters, on analysis, show the following mineralization:

MEDICAL LAKE.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, G. A. Mariner). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 158.00 |
| Sodium chloride (NaCl) | 281.82 |
| Potassium sulphate ($K_2SO_4$) | trace |
| Sodium biborate ($Na_2B_4O_7$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | 2815.57 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 6.37 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 4.98 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 14.68 |
| Aluminum oxide ($Al_2O_3$) | 3.07 |
| Sodium silicate ($Na_2SiO_3$) | 181.77 |
| Organic matter | 9.40 |
| Total solids | 2475.66 |

Medicinal classification, alkaline a, weak saline or (Aa, −Cl). This is a moderately highly mineralized, sodic, bicarbonated, muriated, silicated, alkaline-saline water, possessing diuretic, antacid and slight laxative properties. The waters are used commercially. The East Washington Hospital and Custodial School are located here, and the water used extensively in the institutions for its medicinal and therapeutic properties.

## Moffett's Hot Springs.

(*Skamania County.*)

*Postoffice*, Moffetts. *Location*, in the southeast portion of the state; east of Vancouver, 35 miles; southwest of Hood River, Ore., 40 miles; south of Mount Ranier, 85 miles; south of Tacoma, 100 miles. *Situation*, near the Cascade Rapids of the mighty Columbia River, inside the "Century Drive," near the "Bridge of the Gods." Moffett's Hot Springs, formerly known as Cascade Warm Springs, is situated at the southern foothills of Lookout Mountain, which furnishes a background to the north, while to the south the mighty Columbia River, which rises away up in the hills of the Dominion of Canada, and enters the state in its northwest corner, comes dashing southward, a great, wild, untamed mountain stream leaping over cascades near the springs, presenting a picture of great charm and magnificent grandeur. *Access*, via Cascade Station, on the Spokane, Portland & Seattle Railway,

thence only ¾ mile to the springs. *Hotel,* there is a new modern hostelry, with conveniences. A new bathing establishment is an additional attraction, under the same roof as the new hotel; here are found the latest equipment for the administration of hydrotherapeutic and balneotherapeutic treatments. The water, on analysis, shows the following constituents:

MOFFETT'S HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst not given). |
|---|---|
| Sodium chloride ($NaCl$) | 278.04 |
| Calcium sulphate ($CaSO_4$) | 89.99 |
| Magnesium sulphate ($MgSO_4$) | 12.82 |
| Sodium bicarbonate ($NaHCO_3$) | 81.05 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 19.66 |
| Silica ($SiO_2$) | 37.55 |
| Total solids | 519.11 |
| Temperature, °C. | 85.6 |

Medicinal classification, weak total mineralization or (−T), thermic. The analysis shows a moderately mineralized, thermic, sodic, calcic, sulphated saline water, sulphuretted, possessing antacid and diuretic properties. The water, when cooled, is clear and refreshing to the palate, and is said to be of value in the treatment of digestive disturbances due to acidity and of use in the treatment of the various manifestations of the rheumatic diathesis, especially the hot baths as given here. The treatment is also of value in the treatment of general nervous debility. The waters are used commercially, and are on sale in Portland and other cities nearby.

The following springs were used as resorts:

*Bracket Springs, P. O.,* Edmonds, Snohomish County. No definite information nor satisfactory analysis available.

*Wetemis Mineral Springs, P. O.,* Blockhouse, Klickitat County. Located north of the wheat-growing region of the Klickitat River, 30 miles south of Mt. Adams, the second highest peak of the Cascade Range, the summit of which pierces the clouds at 12,424 feet. There are several springs in the area. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Artesian Mineral Springs, P. O.,* Yakima, Yakima County.

*Schafer's Medical Springs, P. O.,* Dishman, Spokane County.

*Sol Duc Hot Springs, P. O.,* Sol Duc, Clallam County.

## WEST VIRGINIA.

West Virginia extends from 37°6′ to 39°37′ north latitude and from 77°43′ to 83°33′ west longitude, and comprises an area of 24,780

square miles. Most of the state boundaries are natural, that is, formed by rivers or mountain ranges. The general shape of the state is that of an oval, 210 miles long, from southwest to northeast, and 125 miles wide; but two narrow tongues extend northward, between between Pennsylvania and Ohio, and northeastward, between Virginia and Maryland. The entire surface of the state is hilly and mountainous. The main range of the Alleghanies crosses the northeastern section and farther south forms the state boundary line with Virginia. The Alleghany Plateau embraces the greater part of the mountain region, and occupies more than one-third of the state's area. The highest elevations in the state are near the eastern and southern boundary, where the plateau in many places reaches heights exceeding 4000 feet. From thence the state gently slopes over a network of narrow, crooked ridges, with deep gorges or contracted valleys, toward the northwest along the Ohio River. With the exception of the northeastern section, the whole state belongs to the Ohio basin, and is drained by a number of streams flowing from the mountain belt northwestward to the Ohio. The climate of West Virginia is agreeable and healthful, with pure mountain air and freedom from violence of heat and cold. The mean annual temperature ranges from 12.5° to 13.3° C. (55° to 56° F.); the average maximum temperature is between 34.4° and 36.7° C. (94° and 98° F.); the average minimum is between −15.1° and 12.2° C. (5° and 10° F. above zero), although −23.3° C (10° F. below zero) has been recorded.

West Virginia has been credited with having 38 spring localities, with a total of 69 individual springs, 20 of which have been analyzed and 15 used as resorts. West Virginia is noted for its mineral springs. Greenbrier White Sulphur Springs is one of the oldest and most widely celebrated spas in the United States. The best-known and most popular springs are located in the southwestern portion of the state. Most of them are classified as saline-calcic, alkaline-calcic and sulphuretted, carbonated and acid waters. Two localities have waters which can be classed as thermic; the Berkeley Springs, 23.6° C. (75° F.); the Sweet Springs, 26° C. (79° F.). Walton lists 10 spring localities and Crook 10, but many places which were popular twenty-five or more years ago have fallen into disuse and are known no more. The following list is made up principally from correspondence with spring owners and the existing literature, which I have verified as far as possible.

### Berkeley Springs.

(*Morgan County.*)

*Postoffice,* Berkeley Springs. *Location,* in the extreme northeastern corner of the state; north of Winchester, Va., 38 miles; south of Altoona, Pa., 65 miles; northwest of Washington, D. C., 105 miles. *Situation,* in a narrow valley 800 feet above sea level, 6 miles southwest of the

Potomac River. The springs issue from the base of a steep ridge, about 450 feet higher than the surrounding valley. The climatic conditions are ideal; the air is pure, wholesome and invigorating. *Access*, via Hancock Station, on the Baltimore & Ohio Railway, thence by motor over splendid macadam highways, through a beautiful rolling country, picturesque and interesting, 6 miles to the springs. The Baltimore & Ohio Railway also have a branch line into the springs property. *Hotel*, there are 2 hotels, with modern equipment and conveniences. The state of West Virginia owns and controls the property and has recently made an appropriation of funds for the remodeling and equipment of its bathing establishment; the equipment is now being installed. There are a number of springs in the group, but the predominating chemical constituents are practically the same in all. The Berkeley Springs are perhaps the oldest spring resort in America. They have been open continuously for the reception of guests for more than one hundred and fifty years. The original title was vested in Thomas, Lord Fairfax, who made a grant of a few acres, including the springs, to the state, reserving for his own use one spring, still known as Lord Fairfax Spring. The analysis shows the waters to contain the following mineralization:

BERKELEY SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. D. Howard). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | none |
| Sodium chloride ($NaCl$) | 2.50 |
| Sodium sulphate ($Na_2SO_4$) | 10.25 |
| Potassium sulphate ($K_2SO_4$) | 1.99 |
| Calcium sulphate ($CaSO_4$) | 9.79 |
| Sodium nitrate ($NaNO_3$) | 0.45 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 32.98 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 190.55 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | 0.10 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.14 |
| Aluminum oxide ($Al_2O_3$) | 8.50 |
| Organic matter | 4.69 |
| Total solids | 261.94 |
| Temperature °C. | 24.4 |

Gases:
Free carbonic acid, liberal amount.
Oxygen, moderate amount.

This spring flows at the rate of 2,880,000 gallons in twenty-four hours, and may be classed as a lightly mineralized, thermic, calcic, magnesic, bicarbonated alkaline water, carbon-dioxated, clear, sparkling and tasteless. The Berkeley Springs water possesses marked diuretic, antacid and tonic properties. They have had a long and enviable reputation among the leaders of the profession of medicine. The internal use of this water is said to produce excellent results in chronic gastric disturbances due to acidity, also in irritable

conditions of the genito-urinary tract. On account of the predominance of the magnesium and calcium bicarbonate salts, these waters have long had a reputation of upbuilding the bone-growing salts during the period of dentition in children and, as a consequence, many Virginia families take their children there for the summer months. The baths of Berkeley have been celebrated for many years in the treatment of sciatica, gout, eczema and rheumatism. The waters are said to have a pleasing cosmetic effect upon the integumentary system, rendering the skin soft, fresh and elastic, aiding in the removal of tan and freckles.

### Borland Springs.

(*Pleasants County.*)

*Postoffice*, Willow, R.F.D. *Location*, on the extreme western border of the state; west of Clarksburg, 70 miles; southeast of Zanesville, O., 80 miles; northwest of Parkersburg, 20 miles. *Situation*, in the historic West Virginia Hills, overlooking the valley of the Ohio River. The resort is situated in a natural grove of stately old trees. *Access*, via Willow Station, on the Ohio River Branch of the Baltimore & Ohio Railway, thence over a beautiful section of country, 6 miles to the springs. *Hotel*, there is a 3-story structure, with all the conveniences of a modern hotel. The analysis below shows the mineralization:

BORLAND SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, T. C. Wormley). |
|---|---|
| Sodium chloride ($NaCl$) | 4110.45 |
| Magnesium chloride ($MgCl_2$) | 36.55 |
| Magnesium bromide ($MgBr_2$) | 4.79 |
| Magnesium iodide ($MgI_2$) | 0.41 |
| Sodium sulphate ($Na_2SO_4$) | 648.29 |
| Potassium sulphate ($K_2SO_4$) | 387.27 |
| Aluminum phosphate ($Al_2[PO_4]_2$) | 3.97 |
| Sodium bicarbonate ($NaHCO_3$) | 1920.50 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 53.52 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 212.12 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 10.94 |
| Silica ($SiO_2$) | 9.98 |
| Total solids | 7398.79 |
| Temperature, °C. | 13.3 |
| Gases at 0° C. and 760 mm. pressure, cc. per liter: | |
| Carbon dioxide (free) | 30.46 |
| Carbon dioxide set free on evaporation | 298.00 |
| Hydrogen sulphide present. | |

Medicinal classification, alkaline a, saline 2 or (Aa, Cl 2), sulphuretted. This spring is a very moderately highly mineralized, sodic, muriated and bicarbonate saline (bromic, iodic, phosphatic) water, carbon-dioxated and sulphuretted, possessing diuretic, antacid, laxa-

tive and diaphoretic properties. It derives a certain tonic, alterative and restorative influence from the presence of iodine, iron, phosphorus and manganese. It is also an excellent table water, in addition to its potent therapeutic value in the treatment of digestive disturbances when due to hyperacidity. It is also valuable in the treatment of catarrhal conditions of the intestinal tract. In irritable conditions of the bladder and kidneys it has been used with success. It is said that it has been used with pleasing results in renal ascites and in all depraved conditions of the blood and blood-making organs, where an assimilable iron tonic is indicated.

## Capon Springs.

(*Hampshire County.*)

*Postoffice*, Capon Springs. *Location*, in the extreme eastern part of the state; southeast of Rommy, 27 miles; west of Winchester, Va., 22 miles; west from Washington City, 100 miles; west from Baltimore, Md., 125 miles. *Situation*, in a beautiful valley, at the head of a ravine, 1800 feet above sea level; 4 miles up the mountain from Capon River and 2 miles from the summit of Great North Mountain, nestling like a hawk's nest against the mountain side. The hotel bath-house and bottling plant occupy a small plateau, through which flows a small crystal stream, whose waters are from the Capon Springs, at its head. The scenery surrounding this favored spot unfolds like a great panorama, and presents scenic views varied and pleasing. The climatic conditions during the season are all that can be desired. *Access*, via Capon Springs Station, on the Winchester & Western Division of the Pennsylvania Railway, thence only a short distance to the springs. *Hotel*, the largest resort hotel in the south, erected in 1850. It was a popular resort until 1911; when it was destroyed by fire. The present accommodations are 2 small hotels and a number of cottages. Plans have been drawn for $1,000,000 hotel and club house, to be completed in the latter part of 1927. The plans also call for the erection of a modern sanitarium building, to be located within a convenient distance from the hotel and club house. The following analysis shows the mineralization of the water.

The analysis shows this to be a lightly mineralized, calcic, lithic and magnesic bicarbonated, alkaline water, possessing marked diuretic and antacid properties. The iron bicarbonate content and the traces of iodine and manganese impart to the water tonic and alterative properties. The water has the highest endorsement of the most eminent members of the medical profession throughout the United States, in a wide range of diseased conditions, viz: acidosis and disorders of the digestive tract due to acidity and hyperacidity; diseases of the urinary tract, including stone in the kidney and bladder and catarrhal conditions of the kidneys; rheumatism, gout and the uric-acid diathesis and hepatic disorders, etc.

CAPON SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. J. W. Mallet). |
|---|---|
| Sodium chloride (NaCl) | 0.800 |
| Potassium sulphate (KCl) | 2.420 |
| Calcium sulphate ($CaSO_4$) | 8.470 |
| Strontium sulphate ($SrSO_4$) | trace |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.028 |
| Calcium fluoride ($CaF_2$) | trace |
| Sodium nitrate ($NaNO_3$) | trace |
| Sodium iodide (NaI) | trace |
| Sodium bromide (NaBr) | trace |
| Lithium bicarbonate ($LiHCO_3$) | 45.960 |
| Sodium bicarbonate ($NaHCO_3$) | 13.490 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 35.760 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 192.640 |
| Manganous bicarbonate ($Mn[HCO_3]_2$) | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.890 |
| Aluminum oxide ($Al_2O_3$) | 0.250 |
| Silica ($SiO_2$) | 10.100 |
| Total solids | 310.828 |
| Temperature, °C. | 17.8 |
| Gases, cc. per liter: | |
| Oxygen | 0.58 |
| Nitrogen | 1.28 |
| Flow in gallons per day | 72,000 |

The virtues of this water were known to and appreciated by the red men of the forest many centuries before the coming of the white man. As early as 1765 improvements were begun; one Henry Frye built a cabin here for his wife, who was suffering from rheumatism, and for many years thereafter the springs were known as Frye's Springs. The reputation of Capon Springs as a resort began before the Revolution. George Washington and his family resorted here for many years. Daniel Webster delivered here the most highly praised and most bitterly condemned of all his speeches. He said: "If the North nullifies the Fugitive Slave Act the South will have a right to secede." Virginia held the springs in such high esteem that the property continued in the possession of the state for one hundred and thirty years; the state built the bathing establishment, and provided by enactment that the "revenue from the baths should be expended perpetually by the board of trustees in improving and beautifying the property." The waters are bottled and shipped commercially, largely in New York and Philadelphia. The bottling establishment is modern in construction and equipment, every precaution being taken to insure the most meticulous sanitation. (See also Chapter XV.)

## Greenbrier Springs.

(*Summers County.*)

*Postoffice,* Talcott. *Location,* in the southern portion of the state; southeast of Charleston, the capital city, 100 miles; west of Richmond,

Va., 250 miles. *Situation,* in the western foothills of the Blue Ridge Mountains, in the Greenbrier Valley, on the banks of the river of the same name, lying at an elevation of 1800 feet above sea level. The springs and resort are favorably and fortunately situated in a bend of the Greenbrier River, which borders the property for more than 1 mile; just below the springs lies the Canyon of the Big Stony Creek, surrounded by wild, weird and rugged scenery, into the fastness of which the sun never penetrates. Access, via Talcott Station, on the Baltimore & Ohio Railway, thence a distance of 3 miles to the springs. *Hotel,* there is a modern resort hostelry with conveniences for the comfortable accommodation of 75 guests. The bathing establishment is modern in construction and equipment. The analysis below shows the mineralization:

GREENBRIER SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, R. K. Meade). |
|---|---|
| Sodium chloride (NaCl) | 17.28 |
| Sodium sulphate ($Na_2SO_4$) | 271.88 |
| Calcium sulphate ($CaSO_4$) | 97.70 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 235.18 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 316.98 |
| Aluminum oxide ($Al_2O_3$) | 0.85 |
| Silica ($SiO_2$) | 21.49 |
| Total solids | 961.36 |
| Temperature, °C. | 8.9 |
| Gases: | |
| Sulphuretted hydrogen, cc. per liter | 15.6 |

Medicinal classification, weak alkaline b, weak sulphated or (−Ab, −S), sulphuretted. The analysis shows this to be a moderately mineralized, magnesic and calcic, bicarbonated alkaline-saline water, sulphuretted, possessing diuretic, antacid and slight laxative properties. It is useful in the treatment of gastric disturbances due to acidity and in sluggish action of the bowels. It is also of value in the treatment of hepatic disorders and in renal and cystic disturbances.

## Irondale Springs.

(*Preston County.*)

*Postoffice,* R.F.D. No. 2, Independence. *Location,* in northern West Virginia; west of Washington, D. C., 220 miles; northeast of Charleston, the capital city, 190 miles; south of Pittsburgh, Pa., 120 miles. *Situation,* on the western slopes of the Blue Ridge Mountains, at an elevation of 1200 feet above tidewater. *Access,* via the Baltimore & Ohio Railway System to Independence, thence by motor over good mountain highways to the springs. *Hotel,* none; not run as a resort; only bottle and ship the waters. The analysis below shows the mineralization:

IRONDALE SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Fraser & Co.). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.023 |
| Potassium chloride (KCl) | 3.536 |
| Potassium sulphate ($K_2SO_4$) | 19.740 |
| Sodium sulphate ($Na_2SO_4$) | 12.190 |
| Magnesium sulphate ($MgSO_4$) | 16.425 |
| Calcium sulphate ($CaSO_4$) | 276.694 |
| Sodium nitrate ($NaNO_3$) | 16.510 |
| Sodium nitrite ($NaNO_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 14.063 |
| Calcium silicate ($CaSiO_3$) | 22.629 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.500 |
| Mangano-manganic oxide ($Mn_3O_4$) | 1.200 |
| Silica ($SiO_2$) | 0.470 |
| Total solids | 384.980 |

Medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, calcic, magnesic, sodic, sulphated saline water, possessing diuretic, laxative, tonic and alterative properties. This water is bottled and shipped extensively as the "Manacea Water." This water is highly endorsed by prominent physicians in a variety of stomach and bowel disorders, intestinal catarrh, diarrhea, dysentery, colitis and in intestinal stasis. The sulphate radicle is in solution in sufficient quantity to stimulate intestinal secretion and secure bowel action. It has a sedative action to the gastric mucous membrane, and by virtue of this fact is highly recommended in the vomiting of pregnancy. In anemia and chlorosis it exerts a decided tonic and alterative effect. The water is soft, potable.

## Old Sweet Springs.

(*Monroe County.*)

*Postoffice,* Sweet Springs. *Location,* in the center of the famous Old Spring resort region of the Virginias; in the heart of the Appalachian Natural Park, near the eastern border of the state and only ½ mile from the Virginia boundary line, on the western side of the famous Shenandoah Valley; west of Roanoke, Va., 45 miles; south of Greenbrier White Sulphur Springs, 18 miles. *Situation,* in a beautiful, wooded park of 50 acres of rolling lawns, carpeted with "blue grass" and shaded with primeval oaks and other indigenous trees, many of which are centuries old; the whole enlivened with murmuring mountain brooks. The elevation of this beautiful mountain valley is 2500 feet above sea level, presenting a picture of great charm and natural beauty, surrounded by mountainous scenery of surpassing grandeur. *Access,* via the Alleghany Station, on the main line of the Chesapeake & Ohio Railway, thence 10 miles via motor to the springs; via Paint Bank

Station, on the Norfolk & Western Railway, thence 6 miles by motor to the springs; via motor over the great national Roosevelt Trail, 6 miles away, and other state highways of wonderful scenic beauty and attraction. *Hotels*, the hotel includes 6 buildings, of colonial architecture, brick construction, modernized, and 5 large brick cottages and 25 frame cottages. There is a splendid pool for plunge or swimming, 60 by 70 feet, and very attractive in appearance. There are also warm and steam baths of mineral and freestone water. The following analysis shows the mineralization and character of Old Sweet Spring, flowing at the rate of 700,000 gallons daily.

OLD SWEET SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. W. Rogers). |
|---|---|
| Sodium chloride (NaCl) | 13.0 |
| Sodium iodide (NaI) | trace |
| Sodium sulphate ($Na_2SO_4$) | 98.3 |
| Magnesium sulphate ($MgSO_4$) | 193.6 |
| Calcium sulphate ($CaSO_4$) | 211.1 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 882.6 |
| Ferric oxide ($Fe_2O_3$) | 2.6 |
| Silica ($SiO_2$) | 3.0 |
| Total solids | 1404.2 |
| Gasses cc. per liter. | |
| Carbon dioxide | 371.7 |
| Nitrogen | 18.0 |
| Oxygen | trace |
| Hydrogen sulphide | trace |
| Total gases | 389.7 |
| Gases arising as bubbles, per cent: | |
| Carbon dioxide | 18.3 |
| Nitrogen | 71.7 |

Medicinal classification, weak alkaline b2, weak calcic sulphated or (−Ab2, −CaS), carbon-dioxated. This is a moderately mineralized, azotized, calcic, bicarbonated, sulphated alkaline-saline water, carbon-dioxated, possessing diuretic, alterative, tonic and mild laxative properties. It has been endorsed and prescribed by the profession with satisfactory results in disorders of the gastro-intestinal tract and in renal and urinary troubles, and with great satisfaction in rheumatic and arthritic affections. The Old Sweet Springs is one of the oldest pleasure and health resorts in the Virginias, if not in the United States. It has had a historic career since its discovery, in 1764. The first buildings were erected in 1773 and were later succeeded by the present massive brick structure of true Colonial architecture, now thoroughly modernized; in the height of the season, all brilliantly lighted with electricity, it presents a picture of a miniature city.

## Pence Springs.

(*Summers County.*)

*Postoffice*, Pence Springs. *Location*, in the southern part of the state; southeast of Charleston, the capital city, 110 miles; north of Pulaski, Va., 65 miles; west of the celebrated White Sulphur Springs, 32 miles; west of Sweet Chalybeate Springs in Virginia, 50 miles. *Situation*, in the picturesque valley of the beautiful Greenbriar River. The springs issue from the igneous rocks deep below the surface, and pour forth at an elevation of 1725 feet above sea level, surrounded by rough, rugged region of towering hills on both sides of this beautiful valley of cultivated fields. From the hotel terrace the vision takes in a panorama of marvelous beauty and grandeur. *Access*, via the Pence Spring Station, on the main line of the Chesapeake & Ohio Railway; through trains east and west, midway between Cincinnati, O., and Washington, D. C. *Hotel*, there is a modern hotel building of pleasing architectural design, brick construction, with every convenience. The climatic conditions are delightful. The air is bracing and invigorating. The mercury rarely reaches 85 during the hottest summer days, and the nights are always cool. The whole atmosphere of the place is homelike and restful. There are 2 valuable springs in this area, No. 1 (sulpho-alkaline) and No. 2 (magnesia) springs. The waters are pleasingly potable, and may be imbibed in quantities, which in other waters might be excessive and unpleasant. The analyses below show the mineralization:

PENCE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Col. B. M. Hardin). Spring No. 1. | Spring No. 2. |
|---|---|---|
| Sodium chloride (NaCl) | 34.910 | 4.09 |
| Sodium iodide (NaI) | 0.034 | |
| Potassium sulphate ($K_2SO_4$) | 0.890 | 0.89 |
| Sodium sulphate ($Na_2SO_4$) | 11.670 | 31.67 |
| Sodium phosphate ($NaHPO_4$) | trace | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | ... | trace |
| Sodium thiosulphate ($Na_2S_2O_3$) | 6.880 | |
| Sodium sulphide ($Na_2S$) | 7.290 | |
| Sodium biborate ($Na_2B_4O_7$) | 2.890 | |
| Ammonium bicarbonate ($NH_4HCO_3$) | 16.000 | trace |
| Sodium bicarbonate ($NaHCO_3$) | 431.510 | 46.92 |
| Lithium bicarbonate ($LiHCO_3$) | 1.60 | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 44.930 | 54.88 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 36.360 | 110.90 |
| Barium bicarbonate ($Ba[HCO_3]_2$) | ... | trace |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 8.120 | trace |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | ... | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | trace | 11.36 |
| Aluminum oxide ($Al_2O_3$) | 0.800 | 154.38 |
| Silica ($SiO_2$) | 9.470 | 20.45 |
| Total solids | 613.354 | 435.54 |

Spring No. 1 (sulpho-alkaline), medicinal classification, weak alkaline a or (−Aa), sulphuretted. This is a moderately mineralized, sodic, magnesic and calcic, bicarbonated alkaline (strontic) water, carbon-dioxated, sulphuretted, possessing diuretic, antacid, tonic, alterative and restorative properties. This water is highly endorsed in the treatment of gastric irritability, atonic dyspepsia, disease of the bladder and kidneys, skin and liver; it has been used successfully in nervous, run-down conditions.

Spring No. 2 (magnesia), medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, calcic, sodic, magnesic, bicarbonated alkaline water, carbon-dioxated, possessing diuretic, antacid, tonic and alterative properties.

Besides the delightful situation, altitude, scenery, splendid hotel accommodations and the excellent mineral waters, there are among other attractions an excellent golf course, tennis, swimming, fishing, music and dancing; motoring over these mountain highways is an attractive feature of a stay at Pence Springs. (See also Chapter XV.)

### Salt Sulphur and Iodine Springs.

(*Monroe County.*)

*Postoffice*, Salt Sulphur Springs. *Location*, in the eastern section of West Virginia; north of Pulaski, Va., 50 miles; west of Lynchburg, Va., 125 miles; southeast of Charleston, the capital city, 120 miles. *Situation*, in the heart of the Alleghany Mountains, at an altitude of 2000 feet above sea level, amid the most charming and home-like surroundings. *Access*, via Rich Creek Station, on the Virginian Railway (in Virginia), thence by motor, over graded mountain highways, through an interesting mountainous region, a distance of 24 miles to the springs; via Roncerverte Station, on the Baltimore & Ohio Railway, thence a distance of 16 miles to the springs. *Hotels*, there are 2, both of which are now being renovated; private baths are being installed and all other conveniences and appointments added. The owners advise that their present plans call for a bathing establishment, modern in construction and equipment, where every facility will be found for the latest and most approved bathing establishments:

Salt Sulphur Spring, medicinal classification, weak alkaline b, calcic sulphated or (−Ab, CaS), sulphuretted. This is a moderately highly mineralized, calcic, sodic and magnesic, sulphated saline (ferruginous) water, sulphuretted, possessing diuretic, laxative and tonic properties.

The Iodine Spring, medicinal classification, weak alkaline b4, calcic sulphated (iodic) or (−Ab4, CaS (I)), sulphuretted. This is a moderately mineralized, calcic, sodic and magnesic sulphated and bicarbonated, alkaline-saline (ferruginous, iodic, bromic, phosphatic) water,

sulphuretted, azotized, possessing diuretic, antacid, purgative, tonic, alterative and reconstructive properties.

SALT SULPHUR AND IODINE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, W. B. Rogers.) Salt Sulphur Spring. | (Analyst, Dr. Stewart.) Iodine Springs. |
|---|---|---|
| Sodium chloride (NaCl) | 27.02 | 25.67 |
| Magnesium chloride ($MgCl_2$) | 4.44 | 4.79 |
| Calcium chloride ($CaCl_2$) | 1.03 | 9.58 |
| Iodine (I) | trace | 10.78 |
| Sodium bromide (NaBr) | .... | 11.12 |
| Sodium sulphate ($Na_2SO_4$) | 382.58 | 410.64 |
| Magnesium sulphate ($MgSO_4$) | 311.57 | 342.20 |
| Calcium sulphate ($CaSO_4$) | 1452.64 | 1163.48 |
| Sodium phosphate ($Na_2HPO_4$) | trace | 12.49 |
| Potassium bicarbonate ($KHCO_3$) | trace | 64.58 |
| Sodium bicarbonate ($NaHCO_3$) | .... | 299.36 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 91.75 | 194.12 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 284.39 | 914.70 |
| Ferric oxide ($Fe_2O_3$) | 17.11 | 18.14 |
| Aluminum oxide ($Al_2O_3$) | .... | 1.88 |
| Silica ($SiO_2$) | 58.00 | 30.11 |
| Organic matter (azotized) | 100.09 | |
| Total solids | 2730.62 | 3513.42 |
| Temperature, °C. | 10 | 18 |
| Gases: | | |
| Hydrogen sulphide, cc. per liter | 5.1 | 66.1 |
| Oxygen | 2.9 | 2.1 |
| Nitrogen | 7.0 | 15.3 |

These are valuable mineral waters, containing high percentages of active mineral constituents. Both contain a sufficient amount of the sulphate of sodium and magnesium to produce cathartic action. The Iodine Spring carries a high percentage of iodine and bromine, rare constituents in sulphur waters. This spring also has sodium phosphate, 12.49 mg. per liter of water, a reconstructive tonic. This water is very much like that of Challes, in Savoy, and possesses active alterative properties; it has proven highly beneficial in scrofula, syphilis, etc. The waters of both springs are highly beneficial in catarrhal disorders of the intestinal tract, constipation, chronic hepatic disorders, rheumatism, gout and diseases of the skin of a chronic nature. Chronic bronchitis, it is claimed, has been relieved by a sojourn at this resort.

## Shannondale Springs.

### (*Jefferson County.*)

*Postoffice*, Charlestown. *Location*, in the northeastern corner of West Virginia; northwest of Washington, D. C., 75 miles; west of

Baltimore, Md., 80 miles. *Situation*, in the bend of the Shannondale River, at the foot of the Blue Ridge Mountains, at an elevation of about 900 feet above sea level, overlooking the beautiful Shannondale River and the valley of the same name. *Access*, via Charlestown Station, on the Baltimore & Ohio Railway and on the Norfolk & Western Railway, thence a distance of 5 miles by motor, over splendid highways, leading through a beautiful picturesque region to the springs. *Hotel*, the present hotel is modern in equipment and has comfortable accommodations. There are 3 springs in this area; the analyses given below show the mineralization:

SHANNONDALE SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (West Virginia Exper. Station). North Spring. | Middle Spring. | South Spring. |
|---|---|---|---|
| Ammonium chloride ($Na_4Cl$) | 0.15 | 0.10 | 0.08 |
| Lithium chloride (LiCl) | trace | trace | trace |
| Sodium chloride (NaCl) | 39.18 | 39.18 | 39.18 |
| Sodium sulphate ($Na_2SO_4$) | 36.62 | 32.34 | 30.18 |
| Potassium sulphate ($K_2SO_4$) | 6.02 | 5.90 | 7.02 |
| Magnesium sulphate ($MgSO_4$) | 478.04 | 476.86 | 468.89 |
| Calcium sulphate ($CaSO_4$) | 1674.04 | 1542.77 | 1698.18 |
| Strontium sulphate ($SrSO_4$) | 2.67 | | |
| Sodium nitrite ($NaNO_2$) | trace | | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 411.22 | 422.33 | 395.58 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace | trace | trace |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 9.72 | 7.75 | 7.73 |
| Aluminum oxide ($Al_2O_3$) | 0.20 | 0.29 | 0.29 |
| Silica ($SiO_2$) | 30.91 | 32.71 | 31.40 |
| Total solids | 2688.77 | 2560.23 | 2678.53 |
| Gases: | | | |
| Carbon dioxide (free) | present | present | present |
| Sulphuretted hydrogen | present | present | present |

North Spring, Middle Spring and South Spring, medicinal classification, weak alkaline b, calcic sulphated or (−Ab, CaS), sulphuretted. The waters of these 3 springs are so similar in their predominating chemical constituents and amount of total solids that they will be classed as one water and discussed accordingly. Therefore, we will say that they are moderately highly mineralized, calcic and magnesic, sulphated alkaline (ferruginous) water, carbon-dioxated, sulphuretted, possessing diuretic, laxative, tonic and alterative properties. The waters are highly recommended in the treatment of chronic digestive disturbances, sluggish bowel action, hepatic disorders, gout and rheumatism. The use of these waters exerts a happy effect where there is irritation of the genito-urinary tract. The administration of hot baths is said to be very effective in the relief of rheumatic troubles, chronic joint diseases, etc.

## Webster Springs.

(*Webster County.*)

*Postoffice*, Webster Springs. *Location*, in central West Virginia; east of Charleston, the capital city, 100 miles; west of Harrisonburg, Va., 110 miles. *Situation*, in a beautiful valley of a tributary of the Ohio River, lying in the western foothills of the Alleghany Mountains, at an elevation of 1400 feet above sea level. The climate is dry bracing and invigorating. *Access*, via the Webster Springs Station, on a branch and connecting line with the Baltimore & Ohio Railway. *Hotel*, there is a good hotel with modern conveniences in the town. The springs show, on analysis, the following mineralization:

WEBSTER SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 2.856 |
| Lithium chloride (LiCl) | 1.200 |
| Sodium chloride (NaCl) | 5748.700 |
| Magnesium chloride ($MgCl_2$) | 166.500 |
| Calcium chloride ($CaCl_2$) | 315.300 |
| Potassium bromide (KBr) | 19.500 |
| Sodium bromide (NaBr) | 18.800 |
| Potassium iodide (KI) | 0.400 |
| Calcium sulphate ($CaSO_4$) | 34.400 |
| Sodium metaborate ($NaBO_2$) | Heavy trace |
| Sodium nitrate ($NaNO_3$) | Heavy trace |
| Sodium nitrite ($NaNO_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 262.000 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 3.500 |
| Silica ($SiO_2$) | 25.300 |
| Total solids | 6598.456 |
| Gases, cc. per liter: | |
| Carbon dioxide set free on evaporation | 36.6 |
| Hydrogen sulphide present. | |

Medicinal classification, saline 3 or (Cl 3). This is a highly mineralized, sodic, muriated, saline (bromic, iodic, ferruginous) water, carbon-dioxated, sulphuretted, possessing diuretic, laxative, tonic and alterative properties. This water is especially beneficial in scrofulous and syphilitic diseases, abdominal engorgement, chronic constipation, chronic metallic poisoning, functional hepatic disorders, rheumatism, gout and chronic skin diseases, psoriasis, etc.

## White Sulphur Springs.

(*Greenbrier County.*)

*Postoffice*, White Sulphur Springs. *Location*, in the eastern part of the state, near the boundary line which separates this state from

Virginia; southwest of Charleston, the capital city, 125 miles; west of Richmond, Va., 220 miles; west of the celebrated Virginia Hot Springs, about 25 miles. *Situation*, Nature was in a fanciful mood when she fashioned the topography of this beautifully rugged mountain region, which is surrounded by a panorama of mountains, hills and dales. Kates Mountain on the south, 1 mile away, at 3000 feet elevation, Greenbrier Mountain to the north, 3359 feet elevation, Willow Hole Mountain to the east 4 miles, 3000 feet elevation, and White Rock Mountain to the northwest, 3213 feet elevation, the summits of which form a gigantic figure known as Titan, which solitary, stands guard like a giant sentinel over the White Sulphur Springs. The charm and beauty of this delightful spot is enhanced by the natural beauty of forest, hill and dale, through which flow mountain rivulets, little wild untamed streams. *Access*, via White Sulphur Springs, on the main line of the Chesapeake & Ohio Railroad; through trains from the southern and northern cities and from the western cities, with through Pullmans direct to the springs; via motor over the great national highways, through the most beautiful and picturesque country east of the Rocky Mountains. *Hotel*, here is one of the most magnificent resort caravansaries in this country. The style of architecture is Georgian, of pleasing exterior and of ornate design and luxury in appointment and furnishings; throughly modern, with all metropolitan conveniences; complete from the artistic standpoint. A new hotel of the same style of architecture and luxuriousness of appointments will shortly be under construction. It has long been famous as a resort of southern aristocracy, for its southern hospitality and unsurpassed old-fashioned Virginia cooking. Both of these hotels are in direct connection with the bathing establishment. Besides these modern hostelries, there are between 50 and 60 private cottages surrounding the hotels, which are particularly attractive to those who desire quiet and seclusion. The bathing establishment is a new modern building, Georgian in architectural design, and the most complete and luxurious in its appointments of any similar institution of its kind in America, and in variety and character of equipment is not excelled at any spa in the world. This fireproof, three-story bath building is situated north of the Greenbrier, and to the east of the hotel shortly to be constructed, being connected with both by enclosed loggias; here every bath, pack, rub, douche and fomentation, etc., known to the science of hydrotherapy and balneotherapy are administered under the direct supervision of an eminent authority in hydriatics. The chemical composition of waters of White Sulphur Springs is shown in the following analyses:

White Sulphur Spring, medicinal classification, calcic sulphated or (CaS). This is a moderately highly mineralized, calcic, magnesic, sulphated, saline water, sulphuretted, with the sulphates and bicarbonates of magnesium and calcium predominating, containing free carbonic-acid gas and free hydrogen sulphide in solution, possessing laxative, diuretic and alterative properties, and useful in the treatment

of diseases of the stomach, intestines, liver, kidneys and nutritional disorders.

WHITE SULPHUR SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analysts, Froehling & Robertson). | | | |
|---|---|---|---|---|
| | White Sulphur Spring. | Radio-chalybeate Spring. | Alum Spring. | Alvon Spring. |
| Ammonium chloride ($NH_4Cl$) | ... | ... | ... | 0.05 |
| Lithium chloride (LiCl) | 0.20 | trace | ... | trace |
| Sodium chloride (NaCl) | 30.62 | 5.830 | 16.260 | 2.76 |
| Potassium chloride (KCl) | ... | ... | ... | 1.86 |
| Sodium iodide (NaI) | ... | 0.008 | 0.003 | |
| Potassium iodide (KI) | ... | ... | ... | trace |
| Potassium sulphate ($K_2SO_4$) | 8.98 | 1.090 | 11.970 | |
| Sodium sulphate ($Na_2SO_4$) | 31.92 | 2.830 | 2.980 | 7.50 |
| Magnesium sulphate ($MgSO_4$) | 515.72 | 2.460 | 583.110 | 0.56 |
| Calcium sulphate ($CaSO_4$) | 1303.77 | 45.540 | 198.500 | 2.67 |
| Manganous sulphate ($MnSO_4$) | ... | 16.960 | 51.370 | |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | 298.120 | |
| Strontium sulphate ($SrSO_4$) | ... | 1.500 | | |
| Cobalt sulphate ($CoSO_4$) | ... | ... | trace | |
| Lithium sulphate ($LiSO_4$) | ... | ... | trace | |
| Cupric sulphate ($CuSO_4$) | ... | ... | trace | |
| Nickel sulphate ($NiSO_4$) | ... | ... | 15.95 | |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.07 | | | |
| Sodium phosphate ($Na_2HPO_4$) | ... | 0.990 | 0.630 | |
| Sodium nitrate ($NaNO_3$) | trace | ... | 3.590 | trace |
| Sodium nitrite ($NaNO_2$) | ... | ... | ... | none |
| Sodium bicarbonate ($NaHCO_3$) | trace | | | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 60.55 | 6.880 | ... | 17.87 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 156.50 | 20.180 | ... | 93.48 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 2.83 | | | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.98 | | | |
| Ferric sulphate ($Fe_2SO_4$) | ... | 22.770 | | |
| Ferric persulphate ($Fe_2O_3(SO_4)_5$) | ... | ... | 11.29 | |
| Ferric oxide and alumina ($Fe_2O_3$,$Al_2O_3$) | ... | ... | ... | 1.49 |
| Manganum bicarbonate ($Mn[HCO_3]_2$) | trace | | | |
| Aluminum oxide ($Al_2O_3$) | 0.92 | 1.990 | | |
| Silica ($SiO_2$) | 9.97 | 22.940 | 30.44 | 7.78 |
| Sulphuric acid ($H_2SO_4$) (free) | ... | ... | 38.90 | |
| Total solids | 2125.03 | 151.968 | 1268.013 | 136.02 |
| Gases: | | | | |
| Carbon dioxide (free). | | | | |
| Hydrogen sulphide (free). | | | | |
| Radio-activity. Mache units per liter | ... | 2.4 | | |

The Radio-chalybeate Spring is a lightly mineralized, calcic, ferric, sulphated, alkaline (manganic iodic) water, strongly radio-active, besides containing iron in an assimilable form, possessing tonic, alterative and diuretic properties of decided benefit in the treatment of anemia, chlorosis, leukocythemia, and certain nervous nutritional disorders.

The Alum Spring, medicinal classification, weak acid aluminic, weak sulphated 2 or (−AcAl, −S2), sulphuretted. This is a moderately mineralized, magnesic, aluminic, calcic, sulphated, acid water, possessing astringent and tonic properties, and differing considerably from the other two springs. This water is valuable in the treatment of chronic disorders of the intestinal tract, diarrhea, dysentery, colitis and in general scrofulous glandular dystrophies.

The Alvon Spring is a lightly mineralized, sodic, calcic, bicarbonated, alkaline water, carbon-dioxated, flowing in such great quantities that in the early days it was used to furnish power to run a grist mill. The water is limpid, soft and agreeable to the taste. It is bottled and sold extensively as a table water.

The waters of the White Sulphur Springs have the highest endorsement of the most eminent members of the medical profession in this country. For more than a century these waters have been prescribed with marked benefit in a great variety of human ills, always with the most pleasing results to the prescribing physician and with the most happy effects to the patient. The White Sulphur Springs water, so well known in this country, closely resembles the celebrated sulphur waters of Nenndorf, Hesse, Germany. The combination of purgative salts, the salts of calcium, and sulphuretted hydrogen in the same water is a valuable one, and gives to the water a very wide range of application in the treatment of chronic diseases.

The medical department is directed by physicians of the highest standing, with special training in all branches of physiotherapy. There are fully equipped clinical and research laboratories, an electric laboratory with every known modern appliance for electrotherapeutic treatment, including a roentgen-ray department. A competent corps of graduate nurses is constantly in attendance; the establishment offers every facility for sanitarium treatment, without being a sanitarium. Besides the excellent hotels, the unsurpassed cuisine, the luxurious baths, the delightful climate, the invigorating atmosphere, the charming scenery and the delightful social intercourse, there are many opportunities for various forms of outdoor sports. There are 3 golf courses, 1 9-hole and 2 18-hole courses, embodying the most advanced ideas in golf construction; there are 5 excellent clay tennis courts in charge of competent instructors; the hotels maintain a stable of the finest saddle horses in this country, in charge of a master in equitation, and there are numerous bridle paths, which follow the streams through the valleys over the hills, a constant delight for lovers of horsemanship. Motoring is a pleasant pastime, over graded macadam highways, leading through beautiful dales and shady dells, every turn in the road presenting a picture of wonderful charm. Each season at White Sulphur Springs has its peculiar charm. Each is definite in climatic conditions and social atmosphere; in the summer it is the favored resort for society from the South; in the fall, winter and spring it is the "playground" for the élite of the North and West. (See also Chapter XV.)

The following springs were once used as resorts:

*Addison Sulphur Springs, P. O.*, Addison, Webster County. Located on the bank of the beautiful Elk River, at an elevation of 1400 feet above sea level. A number of hotels. There are 2 natural springs and 1 well in this area, all producing the same class of waters, sodic, muriated, calcic and magnesic sulphated, saline, sulphuretted water. No definite information nor satisfactory analysis available.

*Barger's Springs, P. O.*, Talcott, Summers County. The location is near the romantic Greenbrier River, surrounded by craggy cliffs and shaded glens. No definite information nor satisfactory analysis available.

*Blue Sulphur Springs, P. O.*, Blue Sulphur Springs, Cabell County. The location is 13 miles from Huntington, at an elevation of 500 feet above sea level. There are a number of springs in this area, and the waters were quite popular a half century ago. No definite information nor satisfactory analysis available.

*Columbia White Sulphur Springs, P. O.*, Columbia Sulphur Springs, Greenbrier County. The location is in a beautiful valley, at the foothills of the Alleghany Mountains, at an elevation of 2000 feet above sea level. No definite information nor satisfactory analysis available.

*Red Sulphur Springs, P. O.*, Red Sulphur Springs, Monroe County. These springs are located on Indian Creek, surrounded by pine-clad mountains. There are 2 springs in the area, 1 a light saline sulphuretted and the other a light saline calcic. No definite information nor satisfactory analysis available.

*Rose Hill (Hart Well), P. O.*, Willow Island, Pleasants County. The location is in the oil region of West Virginia, 10 miles above Marietta, O. It occupies a plateau 300 feet above the Ohio River. Hotel and cottages. No definite information nor satisfactory analysis available.

*Aurora Highlands Spring, P. O.*, Aurora, Preston County. No definite information nor satisfactory analysis available.

The following springs reported the sale of water in 1924:

*Hallett's Sulphur Well, P. O.*, Alderson, Monroe County.

*Saline Chalybeate Spring, P. O.*, Wheeling, Ohio County.

*Vigora Springs, P. O.*, Wheeling, Ohio County.

*Walnut Hill Spring, P. O.*, Charleston, Kanawha County.

*Wiley Ice Springs, P. O.*, Fairmont, Marion County.

## WISCONSIN.

Wisconsin extends from 42°31′ to 46°58 north latitude and from 87° to 92°53′ west longitude, and embraces an area of 56,040 square miles, of which 1590 square miles are covered by water. The greatest distance from north to south across the state is 315 miles, and the

greatest distance from east to west is 294 miles. The state has a coast line on Lake Michigan of 200 miles and on Lake Superior 120 miles. The surface of the state is nearly a level plain or undulating plateau, with three slopes, divided by a T-shaped ridge. The longitudinal arm of this ridge runs southward, through the center of the state. The surface of the state is studded with numerous lakes, many of them of great natural beauty. Lake Winnebago is the largest of the lakes, being 30 miles long and 11 miles wide. A peculiar diagonal valley runs across the state from southeast to northwest; otherwise there are no sharp irregularities in the surface except the cliffs and the rounded drum-line, mounds, ormorainic peaks and ridges composed of glacial drift. Many curious mounds and earthworks, vestiges of prehistoric or ancient peoples who once inhabited this area, mark here and there the surface along the lakes and water courses. The climate of the state is more temperate than that of the more western interior states. The closeness to the Great Lakes influences the climatic conditions. Its summers are warm and the winters are somewhat severe. The mean summer temperature varies from 21.1° C. (70° F.) in the south, to 15.6° C. (60° F.) in the north; the mean winter temperature from 4.7° C. (25° F.) in the south to about 9.9° C. (15° F.) in the north. The maximum temperature is between 32.2° to 34.1° C. (90° to 95° F.), and the average minimum temperature varies between −23.3° and −31.5° C. (10° and 25° F. below zero).

Wisconsin is credited with having 75 spring localities, with a total of 146 individual springs, of which 51 have been analyzed and 15 used as resorts. The mineral springs of this state are of great value and importance. Many of them have wide reputations and are sold largely in all portions of the country. They are principally alkaline, calcic, chalybeate and a few sulphuretted. The following account is made up from personal correspondence with spring owners, physicians, State and Federal Geological Surveys and from existing literature on the subject.

### Allouez Mineral Springs.

(*Brown County.*)

*Postoffice,* Green Bay. *Location,* in eastern Wisconsin; northeast of Madison, the capital city, 125 miles; north of Milwaukee, 130 miles. *Situation,* near the base of Astor Heights, in the southern part of the city of Green Bay, at an elevation of about 700 feet above tidewater of the Atlantic Ocean. The water gushes from the hillside, through an octagonal marble basin, coming to the surface sparkling in all its purity. *Access,* via the Chicago & Northwestern Railway. *Hotel,* there are a number of good hotels, with all modern convenience in Green Bay. The following analysis shows the mineralization:

ALLOUEZ MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.03 |
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | 3.20 |
| Sodium chloride (NaCl) | 27.70 |
| Magnesium chloride ($MgCl_2$) | 17.10 |
| Magnesium sulphate ($MgSO_4$) | 73.70 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | trace |
| Sodium nitrate ($NaNO_3$) | 36.43 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 145.10 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 317.80 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 1.20 |
| Calcium silicate ($CaSiO_3$) | 25.90 |
| Silica ($SiO_2$) | 7.70 |
| Total solids | 655.86 |
| Gases: | |
| Carbon dioxide free on evaporation | 66.2 |
| Carbon dioxide (free) | 4.9 |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic, bicarbonated, alkaline water, carbon-dioxated, possessing diuretic, antacid and slight laxative effects. The predominating ingredients are the bicarbonates of calcium and magnesium which comprise 70 per cent of the total solids. The bicarbonate of magnesia exerts laxative action, which is augmented by the sulphate also present. This salt exerts antilithic action in the presence of uric acid. This water is sold commercially throughout the country.

## Arctic Springs.

(*Trempeleau County.*)

*Postoffice,* Galesville. *Location,* in southwestern Wisconsin; northwest of Madison, the capital city, 125 miles; west of Fond du Lac, 145 miles; south of Chippewa Falls, 65 miles. *Situation,* at the head of Lake Marinuka, with the village of Galesville at the opposite end. The altitude is about 800 feet above sea level. *Access,* the Chicago & Northwestern Railway. *Hotel,* there are good hotel accommodations at Galesville, but no definite information available concerning accommodations at the springs, of which the following analysis shows the mineralization:

ARCTIC SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, W. W. Daniels). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Sodium chloride (NaCl) | 12.99 |
| Calcium chloride ($CaCl_2$) | 0.85 |
| Potassium sulphate ($K_2SO_4$) | 3.25 |
| Sodium sulphate ($Na_2SO_4$) | 1.19 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 272.58 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 378.13 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 7.20 |
| Aluminum oxide ($Al_2O_3$) | 2.56 |
| Silica ($SiO_2$) | 1.02 |
| Total solids | 679.77 |

Medicinal classification, weak alkaline b2 or (−Ab2). This is a moderately mineralized, calcic, magnesic, bicarbonated alkaline (ferruginous) water, carbon-dioxated, possessing diuretic, antacid and slight tonic properties. The water is highly recommended in the treatment of acid dyspepsia, chronic, renal congestion and in the early stages of Bright's disease; as a tonic it is useful in anemia and general debility.

### Bethesda Mineral Spring.

*(Waukesha County.)*

*Postoffice*, Waukesha. *Location*, in the southeast corner of the state; west of Milwaukee, 16 miles; northwest of Chicago, Ill., 98 miles; east of Madison, the capital city, 60 miles. *Situation*, in a beautiful rolling region, dotted with innumerable lakes, 800 feet above sea level, amid a beautifully wooded section, gravelly, sandy soil, well drained and healthful. *Access*, via Waukesha Depot, on the Chicago & Northwestern Railway, Minneapolis & St. Paul and Sault Ste. Marie Railway, and the Chicago & St. Paul Railway; via half-hourly motor bus from Milwaukee. *Hotels*, there are about a dozen good hostelries and a well-equipped sanitarium. The bathing establishment connected with the sanitarium is well equipped with the latest modern equipment for the practice of balneotherapy. The water, on analysis, shows the following mineralization:

BETHESDA MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, M. S. Nichols). |
|---|---|
| Sodium chloride ($NaCl$) | 37.6 |
| Potassium chloride ($KCl$) | 6.8 |
| Calcium chloride ($CaCl_2$) | 3.9 |
| Calcium nitrate ($Ca[NO_3]_2$) | 39.4 |
| Magnesium sulphate ($MgSO_4$) | 96.5 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 324.0 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 132.9 |
| Ferric bicarbonate ($Fe_2[HCO_3]_2$) | 0.4 |
| Lithium bicarbonate ($LiHCO_3$) | trace |
| Aluminum oxide ($Al_2O_3$) | 0.2 |
| Silica ($SiO$) | 14.9 |
| Total solids | 656.6 |

Medicinal classification, weak alkaline b or (−Ab). This is a moderately mineralized, calcic, magnesic, bicarbonated alkaline water, flowing at the rate of 500,000 gallons daily. The water is clear, sparkling and salutary to the taste. The predominant chemical feature of this water is the abundance of bicarbonates, more than 70 per cent of the whole; this distinguishing characteristic accounts for the mild alkaline reaction and the delightful softness which distinguishes Bethesda water. The name is of Biblical origin, John, V. 2, and translated from the Hebrew it means "a place of flowing water."

This is a fairly potent calcic, bicarbonated alkaline water, and exerts antacid and diuretic properties; it is highly endorsed by the profession in irritation of the genito-urinary tract and in gastric disturbances due to hyperacidity. The water has been bottled and shipped commercially for almost sixty years.

### Chippewa Springs.

*(Chippewa County.)*

*Postoffice*, Chippewa Falls. *Location*, in northern Wisconsin; northwest of Madison, the capital city, 170 miles; west of Green Bay, 170 miles. *Situation*, on the east side of the Chippewa River, in the valley drained by the river of the same name; the elevation is about 1000 feet above sea level, surrounded by a rolling undulating region, well drained and healthful. The soil is a sandy loam, overlying the upper Cambrian (Potsdam) sandstone, possibly 200 feet in thickness, and beneath which is a strata of pre-Cambrian granite, also of great thickness; water circulating in the nether world finds a fault in the granite, and at last percolates the sandstone, and the hydrostatic pressure below forces it through a fissure in the earth's crust, and there bursts forth a spring of the purest water. *Access*, via the Chicago, Milwaukee & St. Paul Railway and the Chicago & Northwestern, the depot being only a short distance from the springs. The Yellowstone (trail) Highway also traverses this section, a delight for motorists. *Hotel*, no accommodations for guests, but there are good hotels in the town offering modern accommodations. There are 3 springs in the area, but the main spring is the one being used at the present time. The following analysis shows the mineralization:

CHIPPEWA SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Dr. Chas. Drew). |
|---|---|
| Potassium chloride ($KCl$) | 1.09 |
| Sodium chloride ($NaCl$) | trace |
| Potassium sulphate ($K_2SO_4$) | 0.09 |
| Sodium sulphate ($Na_2SO_4$) | 2.77 |
| Calcium phosphate ($Ca_3[PO_4]_2$) | 0.17 |
| Sodium bicarbonate ($NaHCO_3$) | 3.33 |
| Magnesium bicarbonate ($MgHCO_3]_2$) | 14.87 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 18.98 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | faint trace |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.51 |
| Calcium silicate ($CaSiO_3$) | 2.24 |
| Silica ($SiO_2$) | 6.08 |
| Total solids | 50.13 |
| Flow in gallons per day | 125,000 |

The analysis shows this to be a slightly mineralized, calcic and magnesic bicarbonated alkaline water, possessing diuretic and slight tonic

properties. It is indicated wherever a pure water is required. It should exert pleasing diuretic action on the renal and vesical apparatus. It should also relieve gastric irritation due to acidity. It is one of the purest waters, from a sanitary standpoint, that we have found. It can be imbibed with impunity, and will be found acceptable to the most delicate stomach.

### Elysian Spring.

(*Crawford County.*)

*Postoffice*, Prairie du Chien. *Location*, in extreme southwestern Wisconsin; west of Madison, the capital city, 90 miles; south of La Cross, 55 miles. *Situation*, east of the Mississippi River a few miles, and lying in the lowlands of this region. The well pierces the upper Cambrian (Potsdam) sandstone lying below the thick deposits of alluvial sand, which protects the underground water supply from surface contamination. The water is very pure and contains large quantities of free carbonic-acid gas, which imparts to the water its beautiful sparkling properties. *Access*, Prairie du Chien, on the Chicago, Milwaukee & Northwestern Railway, only a short distance away. *Hotel*, no accommodations for guests, but good hotels in the town. The waters are bottled and shipped extensively. The bottling plant is modern in construction and equipment, every precaution being taken to insure sanitary handling of a medicinal water. The analysis below shows the mineralization:

ELYSIAN MINERAL SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, V. Lenher). |
|---|---|
| Sodium chloride ($NaCl$) | 1490.18 |
| Potassium sulphate ($K_2SO_4$) | 74.26 |
| Sodium sulphate ($Na_2SO_4$) | 129.35 |
| Magnesium sulphate ($MgSO_4$) | 274.28 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | 14.47 |
| Potassium bicarbonate ($KHCO_3$) | 193.44 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 536.98 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 11.38 |
| Silica ($SiO_2$) | 8.38 |
| Total solids | 2732.72 |
| Gases: | |
| Carbon dioxide (free), cc. per liter | 2.27 |

Medicinal classification, weak alkaline b2, weak saline 4 or (−Ab2, −Cl 4). This is a moderately highly mineralized, calcic and potassic, bicarbonated and sodic muriated alkaline-saline water, carbon-dioxated, possessing diuretic, antacid, laxative and tonic properties. It should be valuable in the treatment of digestive disturbances due to acidity and hyperacidity. Its sulphate ions should exert pleasing laxative action, and its alkalinity imparts to it a pleasing action on the renal function.

### Epsom Spring.

*(Green Lake County.)*

*Postoffice,* Green Lake, via Ripon. *Location,* in the beautiful lake region of the state; northeast of Madison, the capital city, 60 miles; west of Fond du Lac, 20 miles. *Situation,* on the margin of Green Lake, amid a charming picturesque hilly region, 900 feet above sea level. The spring and hotel overlook the beautiful placid waters of Green Lake. *Access,* via Ripon Station, on the Chicago, Milwaukee & St. Paul Railway and by the Chicago & Northwestern Railway. *Hotel,* there is a modern resort hostelry. The spring issues from a fault in the earth's crust, at a point near the hotel. The analysis below shows the mineralization:

EPSOM SPRING.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, F. A. Gilman). |
|---|---|
| Lithium chloride (LiCl) | trace |
| Potassium chloride (KCl) | trace |
| Sodium chloride (NaCl) | 3.29 |
| Magnesium sulphate ($MgSO_4$) | 308.25 |
| Ferrous sulphate ($FeSO_4$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 152.13 |
| Silica ($SiO_2$) | 9.08 |
| Total solids | 472.75 |

Medicinal classification, weak total mineralization or (−T). This is a moderately mineralized, magnesic, sulphated saline (lithic ferruginous) water, carbon-dioxated, possessing diuretic and purgative properties. The water is endorsed by the local profession, and used with success in the treatment of catarrhal conditions of the intestinal tract. A splendid golf course across the lake, boating and swimming on the lake add to the diversions for a pleasant summer vacation.

### Fort Crawford Mineral Well.

*(Crawford County.)*

*Postoffice,* Prairie Du Chien. *Location,* in southwestern Wisconsin; west of Madison, the capital city, 90 miles; south of La Crosse, 65 miles. *Situation,* in the valley of the Mississippi River, just above the intersection of the Wisconsin River with the Mississippi, surrounded by a prairie region, gently rolling. The altitude is about 800 feet above tidewater. *Access,* via the Chicago, Burlington & Quincy Railway and the Milwaukee & St. Paul Railway. *Hotel,* there are good hotel accommodations in the town. The well was bored in 1876; depth, 960 feet; flowing a stream 6 inches in diameter, with hydrostatic pressure of 20 pounds to the square inch. The analysis shows the mineralization as follows:

FORT CRAWFORD MINERAL WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. Bode). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | trace |
| Potassium chloride (KCl) | 64.98 |
| Sodium chloride (NaCl) | 1542.42 |
| Sodium sulphate ($Na_2SO_4$) | 218.88 |
| Calcium sulphate ($CaSO_4$) | 262.99 |
| Sodium bromide (NaBr) | 2.22 |
| Sodium phosphate ($Na_2HPO_4$) | trace |
| Sodium bicarbonate ($NaHCO_3$) | trace |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 303.89 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 17.17 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 6.37 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 11.28 |
| Silica ($SiO_2$) | 65.66 |
| Total solids | 2495.86 |

Medicinal classification, weak saline 4, weak sulphated or (−Cl4, −S). This is a moderately highly mineralized, calcic sodic, muriated, sulphated, saline (bromic, ferruginous) water, carbon-dioxated, possessing antacid, diuretic, laxative and tonic properties, resembling somewhat the Saratoga waters, though somewhat milder. The waters are well adapted to that class of diseased conditions in which this class of waters are indicated. A well-equipped sanitarium is conducted with the hotel; ample facilities and accommodations for guests. This is also an excellent table water.

## Nadruho Springs.

(*Jefferson County.*)

*Postoffice*, Palmyra. *Location*, in the southeastern section of the state; slightly southeast of Madison, the capital city, 45 miles; north of Chicago, Ill., 118 miles. *Situation*, in Mineral Springs Park, at an elevation of 850 feet above sea level. The springs, several in number, 6 of which are located in the park, could be covered with a canvas 40 feet square. The area of the park comprises 8 acres, beautifully landscaped, and covered with natural forest trees of oak, maple, locust and black cherry. One mile away is the famous "Kettle Mountains," a reminiscence of the early glacial age. The soil is dry, sandy and porous, overlaying glacial deposits of gravel, which afford the best natural drainage and filtration. The climate is dry and bracing. The scenery here is noted for its tranquil beauty and loveliness. Spring Lake is one of the gems of the state, with its bottom covered with mosses and other aquatic plants, which bloom and blossom in midsummer. *Access*, via the Chicago, Milwaukee & St. Paul Railway to Palmyra Station, thence ½ mile to the springs. *Hotel*, this is a substantially constructed brick building which was formerly conducted as a high-class sanitarium, but is now conducted as the Mandaback Memorial Druggist Home, open throughout the year, as

a place of retreat for unfortunate, disabled, sick or retired members of the Pharmaceutical Association. The establishment has a modernly equipped bathing department, fully fitted with the most approved apparatus for the scientific practice of hydrotherapy and balneotherapy. The most valuable feature of the retreat or resort is the large number and variety of mineral springs. The analyses of 6 of the more important springs are given below:

NADRUHO SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, Prof. E. G. Smity; recalculations by Paul J. Mandebach). | | | | | |
|---|---|---|---|---|---|---|
| | Spring No. 1. | Spring No. 2. | Spring No. 3. | Spring No. 4. | Spring No. 5. | Spring No. 6. |
| Sodium chloride (NaCl) | 4.38 | 3.18 | 3.68 | 3.58 | 3.58 | 3.58 |
| Potassium sulphate ($K_2SO_4$) | 4.38 | 4.88 | 3.28 | 4.17 | 4.49 | 4.77 |
| Sodium sulphate ($Na_2SO_4$) | ... | 5.68 | 2.19 | 3.58 | 3.99 | 2.38 |
| Calcium sulphate ($CaSO_4$) | 16.97 | 8.56 | 19.66 | 18.46 | 2.19 | |
| Sodium phosphate ($Na_2HPO_4$) | 2.07 | 5.68 | 2.19 | 0.18 | 0.58 | 0.68 |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | ... | ... | 3.49 | 3.49 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 203.64 | 201.24 | 223.73 | 221.76 | 198.67 | 200.35 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 258.30 | 275.27 | 265.29 | 269.36 | 246.20 | 240.40 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 0.89 | 0.89 | 4.38 | 9.28 | 15.45 | 13.27 |
| Aluminum oxide ($Al_2O_3$) | 0.39 | 0.39 | 0.58 | 0.78 | 0.58 | 3.90 |
| Silica ($SiO_2$) | 13.58 | 13.97 | 14.38 | 13.01 | 14.97 | 15.36 |
| Total solids | 504.60 | 519.74 | 539.36 | 544.20 | 494.19 | 488.18 |

Spring No. 1, Spring No. 2, Spring No. 3, Spring No. 4, Spring No. 5 and Spring No. 6, medicinal classification, weak alkaline b or (−Ab).

The predominating chemical constituents in the waters of these several springs are quite similar in percentage composition. They are all moderately mineralized, calcic and magnesic, bicarbonated alkaline (phosphatic, ferruginous) waters, carbon-dioxated, possessing diuretic, antacid, slight tonic and alterative properties. The waters are highly endorsed in disturbances of the genito-urinary tract and in disorders of the digestive organs due to acidity.

## Sheboygan Mineral Well.

(*Sheboygan County.*)

*Postoffice*, Sheboygan. *Location*, in eastern Wisconsin; north of Milwaukee, 60 miles; south of Green Bay, 55 miles. *Situation*, at the mouth of the entrance of the Sheboygan River into Lake Michigan, at an elevation of about 650 feet above tidewater of the Atlantic Ocean. The well is located in Fountain Park, and the water issues from a depth of 1500 feet below the surface, coming from granite bed rock. There is considerable hydrostatic pressure, estimated to be

52½ pounds to the square inch, or sufficient to raise a column of water to a height of 115 feet. *Access*, via the Fond du Lac Division of Chicago & Northwestern Railway. *Hotels*, there are good hotels, with all modern conveniences for the comfortable entertainment of guests. The water comes to the surface, pure, bright and sparkling, free from all surface contamination. The analysis below shows the mineralization:

SHEBOYGAN MINERAL WELL.

| | Parts per 1,000,000. (Analyst, J. K. Haywood). |
|---|---|
| Ammonium chloride ($NH_4Cl$) | 0.392 |
| Lithium chloride (LiCl) | 1.200 |
| Potassium chloride (KCl) | 22.100 |
| Sodium chloride (NaCl) | 1976.700 |
| Potassium bromide (KBr) | trace |
| Potassium iodide (KI) | faint trace |
| Sodium sulphate ($Na_2SO_4$) | 334.900 |
| Magnesium sulphate ($MgSO_4$) | 320.300 |
| Calcium sulphate ($CaSO_4$) | 98.300 |
| Sodium metaborate ($NaBO_2$) | trace |
| Sodium nitrate ($NaNO_3$) | 3.030 |
| Sodium nitrite ($NaNO_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 874.000 |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 2.800 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.300 |
| Silica ($SiO_2$) | 13.100 |
| Total solids | 3647.122 |
| Gases cc. per liter: | |
| Carbon dioxide (free), supersaturated. | |
| Carbon dioxide set free on evaporation to dryness | 121.2 |

Medicinal classification, weak alkaline b2, saline, weak sulphated 2 or (−Ab2, Cl, −S2) carbon-dioxated. This water is seen to be a moderately highly mineralized, sodic, muriated and calcic sulphated and bicarbonated, alkaline-saline water, carbon-dioxated, possessing diuretic, laxative, tonic and alterative properties. The predominating chemical constituents of this water are quite similar to the Kissengen Springs. It has practically the same therapeutic properties as those waters and is indicated for the same conditions. This water exerts a stimulating action on the mucous membranes and promotes secretion; therefore, it is an admirable water for the relief of chronic constipation. It exerts a favorable action in a large class of morbid conditions due to a deranged circulation and defective secretion, functional disturbances of the liver, chronic intestinal stasis, anemia, chlorosis and rheumatic disorders.

## Sparta Mineral Wells.

(*Monroe County.*)

*Postoffice*, Sparta. *Location*, southwest of central Wisconsin; northwest of Madison, the capital city, 90 miles; southwest of Grand

Rapids, Mich., 65 miles. *Situation*, in a fertile, rolling, prairie region, at an elevation of about 900 feet above tidewater. *Access*, via the Chicago, Milwaukee & St. Paul Railway. *Hotel*, there are good hotels in Sparta, but definite information of the class of accommodations at the wells unavailable. The wells are 12 in number, the analyses of 2 of which are given below:

SPARTA MINERAL WELLS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, J. M. Hirsh.) Magnetic Well. | (Analyst, G. Bode.) Artesian Well. |
|---|---|---|
| Sodium chloride ($NaCl$) | 2.05 | 10.5 |
| Calcium chloride ($CaCl_2$) | 8.55 | 9.5 |
| Sodium iodide ($NaI$) | trace | |
| Potassium sulphate ($K_2SO_4$) | 9.14 | |
| Sodium sulphate ($Na_2SO_4$) | 31.46 | 4.6 |
| Calcium sulphate ($CaSO_4$) | 2.39 | 35.4 |
| Sodium phosphate ($Na_2HPO_4$) | 0.85 | |
| Aluminum phosphate ($AlPO_4$) | 0.85 | |
| Sodium bicarbonate ($NaHCO_3$) | 3.70 | 9.5 |
| Lithium bicarbonate ($LiHCO_3$) | trace | 9.5 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 92.80 | 8.5 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 9.14 | 60.5 |
| Ammonium bicarbonate ($NH_4HCO_3$) | trace | |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace | |
| Barium bicarbonate ($Br[HCO_3]_2$) | trace | |
| Ferrous bicarbonate ($Fe[HCO_3]_2$) | 323.65 | 10.0 |
| Manganese bicarbonate ($Mn[HCO_3]_2$) | trace | |
| Silica ($SiO_2$) | 3.93 | 10.0 |
| Total solids | 488.51 | 168.0 |

Magnetic Well, medicinal classification, very weak ferruginous 4 or (− −Fe 4). This is a moderately mineralized, ferruginous, magnesic calcic bicarbonated, alkaline water, possessing decided ferruginous properties; in fact, it carries 323 mg. of the bicarbonate of iron to the liter of water, the other ingredients all being very low; traces of iodine, strontium, barium, etc. The splendid tonic water is indicated whereever the blood and blood-making organs need toning up, anemia, chlorosis and general debility.

Artesian Well is a lightly mineralized, calcic, sodic, bicarbonated, alkaline (lithic, ferruginous) water, carbon-dioxated, possessing diuretic, antacid and tonic properties.

## White Rock Mineral Springs.

### (*Waukesha County.*)

*Postoffice*, Waukesha (100 Broadway, New York City). *Location*, in the southeastern section of the state; northwest of Chicago, Ill., 98 miles; east of Madison, the capital city, 60 miles; west of Milwaukee, 16 miles. *Situation*, in a beautiful rolling section of country, sur-

rounded by lakes, there being more than 30 in the county. The springs issue from a fault in the igneous rock near the banks of the Fox River, at an elevation of 800 feet above sea level, in a rolling, well-wooded country, sandy surface and well drained. This lake region is a veritable playground during the summer season. The lakes with their hotels and bungalows furnish accommodations for thousands of visitors from the Northwest. *Access*, via the Chicago & Northwestern Railway and the St. Paul Railway. *Hotels*, there are a large number of excellent hotels in Waukesha, offering every comfort and convenience. The prime attraction here is the large number of mineral springs, one of the best known and widely advertised being the White Rock Spring. The following analysis, No. 1 made by J. K. Haywood, of the Bureau of Chemistry, Washington, D. C., shows the mineralization as it flows from Nature's laboratory; No. 2 shows the analysis made by the chemist for the spring:

WHITE ROCK MINERAL SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000. (Analyst, J. K. Haywood.) No. 1. | (Analyst, John H. Wright.) No. 2. |
|---|---|---|
| Ammonium chloride ($Na_4Cl$) | 0.125 | |
| Lithium chloride (LiCl) | 76.400 | 243.6 |
| Potassium chloride (KCl) | 5.700 | |
| Sodium chloride (NaCl) | 576.300 | 24.1 |
| Magnesium chloride ($MgCl_2$) | 26.200 | |
| Magnesium sulphate ($MgSO_4$) | 49.600 | |
| Calcium sulphate ($CaSO_4$) | ... | 54.4 |
| Sodium nitrate ($NaNO_3$) | 6.070 | 4.8 |
| Sodium nitrite ($NaNO_2$) | 0.024 | |
| Sodium bicarbonate ($Na[HCO_3]_2$) | ... | 100.4 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 125.200 | 71.1 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 327.700 | 270.0 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.570 | 0.4 |
| Silica ($SiO_2$) | 12.400 | 13.2 |
| Total solids | 1206.289 | 782.0 |
| Gases, cc. per liter: | | |
| Carbon dioxated (free), supersaturated. | | |
| Carbon dioxide set free on evaporation | 64.4 | |

No. 1 (Haywood analysis), medicinal classification, weak alkaline b, weak saline 2 or (−Ab, −Cl 2), carbon-dioxated. This is shown to be a moderately mineralized, sodic and lithic muriated, alkaline-saline water, carbon-dioxated.

No. 2 (Wright's analysis), medicinal classification, weak alkaline b (−Ab). This is is shown to be a moderately mineralized, calcic and sodic bicarbonated and lithic muriated alkaline water, carbon-dioxated.

The White Rock Mineral Springs Company state on the label that the lithia is added. Before bottling the water is heavily charged with carbonic-acid gas, which makes the water very palatable. It is very popular as a potable table water.

The following springs were once used as resorts:

*Hackett Springs, P. O.*, Hale's Corners, Milwaukee County. The information we have about this spring area is quite meager. There is said to be hotels and cottages. No definite information nor satisfactory analysis available.

*Salvator Mineral Springs, P. O.*, Green Bay, Brown County. This is said to be an excellent calcic, sodic, magnesic alkaline water, but no definite information nor satisfactory analysis available.

*Waukesha Mineral Springs, P. O.*, Waukesha, Waukesha County. There are a number of good hotels and boarding houses. The majority of the springs are operated commercially. It was difficult to secure any definite information or satisfactory analysis.

The following springs reported the sale of water in 1924:

*Almanaris Spring, P. O.*, Waukesha, Waukesha County.
*Anderson's Spring, P. O.*, Waukesha, Waukesha County.
*Arbutus Mineral Spring, P. O.*, Oconto, Oconto County.
*Arcadian Spring, P. O.*, Waukesha, Waukesha County.
*Artesia Spring, P. O.*, Milwaukee, Milwaukee County.
*Badger State Mineral Water Co., P. O.*, Darlington, Lafayette County.
*Bay City Spring, P. O.*, Ashland, Ashland County.
*Bethania Mineral Spring, P. O.*, Osceola, Polk County.
*Bryant Silver Spring, P. O.*, Madison, Dane County.
*Castalia Spring, P. O.*, Wauwatosa, Milwaukee County.
*Clysmic Spring, P. O.*, Waukesha, Waukesha County.
*Crystal Spring, P. O.*, Sheboygan, Sheboygan County.
*Crystal Spring, P. O.*, Waupaca, Waupaca County.
*Darlington Mineral Spring, P. O.*, Darlington, Lafayette County.
*"Famous" Genseng Bottling Co., P. O.*, Menomonie Falls, Waukesha County.
*Glenn Rock Waukesha Spring, P. O.*, Waukesha, Waukesha County.
*Horeb Crystal Spring, P. O.*, Waukesha, Waukesha County.
*Indian Mineral Spring, P. O.*, Menomonee Falls, Waukesha County.
*Kusche Spring, P. O.*, Oshkosh, Winnebago County.
*"Lebenwasser," J. J. Handeln, P. O.*, Green Bay, Brown County.
*Maribel Mineral Spring, P. O.*, Maribel, Manitowoc County.
*Maskanozes Spring, P. O.*, Butternut, Ashland County.
*Minniska Spring, P. O.*, Waukesha, Waukesha County.
*Nee-Ska-Ra Spring, P. O.*, Wauwatosa, Milwaukee County.
*Old Faithful Spring, P. O.*, Wauwatosa, Milwaukee County.
*Roxo Spring, P. O.*, Waukesha, Waukesha County.
*St. John Mineral Spring, P. O.*, Green Bay, Brown County.
*Silurian Spring, P. O.*, Waukesha, Waukesha County.
*Sheridan Mineral Spring, P. O.*, Lake Geneva, Walworth County.
*Silver Spring, P. O.*, Madison, Dana County.
*Solon Springs, P. O.*, Solon Springs, Douglas County.
*Sparkling Spring, P. O.*, Kenosha, Kenosha County.

*Spring Grove Epsom Spring, P. O.*, Green Lake, Green Lake County.
*Still Rock Spring, P. O.*, Waukesha, Waukesha County.
*Sulphur Mineral Springs, P. O.*, Oshkosh, Winnebago County.
*Waukesha Fox Head Spring, P. O.*, Waukesha, Waukesha County.
*Wilmette Spring, P. O.*, Cooper Station, Racine County.

## WYOMING.

Wyoming extends from 41° to 45° north latitude and from 104° to 111° west longitude, and comprises an area of 97,890 square miles. The state is rectangular in shape, measuring 355 miles from east to west and 276 miles from north to south. The whole state is a lofty plateau, including almost the entire breadth of the Rocky Mountain System. The Continental Divide crosses it from the northwest corner to the middle of the southern boundary. The plateau has an elevation of from 5000 to 7000 feet above sea level. The principal ranges of the Rockies in Wyoming are the Wind River, in the northwest, with several peaks over 13,000 feet high; Big Horn, north of the center, more than 100 miles long; Laramie in the east; Bishop, west of the main chain. The extreme northwestern portion of the state is a rugged complex of lofty mountains and plateaus cut by numerous canons, and their region is now owned by the Federal Government and maintained as Yellowstone National Park. The highest elevation in the state is Fremont's Peak, situated in the Wind River Range, with an altitude of 13,790 feet. The climate of Wyoming is dry and sunny, pleasant and healthful; in the valleys and on the plateaus the annual temperature is between 4.4° and 10° C. (40° and 50° F.). In most years the maximum rises to 37.8° (100° F.) and the minimum falls to −34.4° C. (30° F. below zero).

Wyoming is credited with 41 spring localities, with a total of 2244 springs, of which 2205 are in one locality—Yellowstone National Park. This leaves only about 41 localities outside of the springs in the park. The list is doubtless far from complete, as many parts of the state are still in the wilds of Nature. The waters found in the state are principally silicious, calcic and sulphuretted, with a few saline and chalybeate waters. Most of the waters within the Yellowstone Reservation are thermic, ranging from 16.7° to 94.4° C. (63° to 202° F.). Outside the Yellowstone National Park, few of Wyoming's springs are used as resorts; most of them are unimproved and of little importance. Neither Moorman, Walton or Bell mention any springs within the State, and Crook mentions only one locality outside of the park.

### Big Horn Hot Springs.

(*Hot Springs County.*)

*Postoffice*, Thermopolis. *Location*, about 60 miles northwest from the center of the state; about 90 miles southwest from Yellowstone

National Park; 5 miles north of Wind River Canyon, one of the great natural formations of the world. *Situation*, in a dimple, made by the smile of Nature, located on the banks of the Big Horn River, one of the untamed streams of the Rockies, where the climate is never too hot or too cold. *Access*, depot on the main line of the Burlington route, 1000 feet from the springs; via the Yellowstone, Buffalo & Atlantic and Yellowstone Pacific Park to Park Highway. *Hotels*, there are several, open all the year round, for the entertainment of guests; besides there are apartments and boarding houses, with rates to suit the purse of all classes. The springs are 4 in number: Black Sulphur, White Sulphur, Ponce de Leon and Big Horn Hot Springs; the analysis of the latter is given below:

BIG HORN HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst unknown). |
|---|---|
| Potassium chloride (KCl) | 175.6 |
| Sodium chloride (NaCl) | 449.2 |
| Sodium sulphate ($NaSO_4$) | 259.1 |
| Magnesium sulphate ($MgSO_4$) | 333.4 |
| Calcium sulphate ($CaSO_4$) | 225.6 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 693.7 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 3.9 |
| Silica ($SiO_2$) | 85.5 |
| Total solids | 2226.0 |

Temperature, 57.4° C. (135° F.).

Medicinal classification, weak alkaline b2, weak saline 2, weak sulphated 2 or (−Ab2, −Cl2, −S2), thermic.

This is a moderately highly mineralized, thermic, calcic, magnesic, sodic, sulphated alkaline-saline water, sulphuretted, flowing at the rate of 18,400,000 gallons each twenty-four hours, at a temperature of 57.4° C. (135° F.), and claimed to be the largest hot spring in the world. Under treaty, made in 1896, with the Shoshone and Arapahoe Indians, the reserve of 640 acres of land on which the springs are located, was deeded to the Department of the Interior, or Federal Government; this treaty provided that the waters were to be and remain free forever for both the whites and Indians alike. The reservation is administered under the authority of the state of Wyoming, and the arrangement also provides that for all time one-fourth of the waters shall be free to visitors from all parts of the world.

The water is recommended in rheumatic and arthritic disorders and for disturbances of the gastro-intestinal tract, irritation of the genito-urinary tract and diseases of the skin. The state maintains a free bath-house with trained assistants for men and women. The Woods Hotel and the Hopewell Sanitarium both have modern equipped bathing establishments, directed by a competent physician, with trained masseurs and all the latest appurtenances for the scientific administration of hydrotherapeutic treatments, with accommodation for both ladies and gentlemen.

The Big Horn Hot Springs, nestling on the banks of the Big Horn River, one of the most picturesque streams in the great Rockies, one of the few rivers of the world running north, and has many nearby natural attractions. The Devil's Punch Bowl, a natural bowled-out depression in the earth, partly filled with hot water, and several hundred feet from rim to rim, is a freak of Nature in this garden spot of the Rockies; Monument Hill, one of the highest peaks in the state, shoots up almost perpendicularly to the dizzy height of 5350 feet.

There are many opportunities for indulgence in out-door amusements, golf, tennis, horseback riding, mountain climbing and motoring over the wonderful scenic highways of this picturesque region. At the mouth of the Wind River Canyon a wide safe roadway was opened in July, 1924, which has three big highway tunnels in the 11 miles of roadway through the canyon, the tunnels being cut through solid rock and costing the State and Federal Governments $1,000,000.

## De Maris Needle Bath Springs.

(*Big Horn County.*)

*Postoffice*, Cody. *Location*, in northwestern Wyoming; east of the Yellowstone National Park, 50 miles; east of Sheridan, 110 miles; west of Basin, the county seat, 60 miles. *Situation*, in the heart of the Rocky Mountains, at the mouth of the mighty Shoshone Canyon, on the banks of the Shoshone River, at an elevation of about 7000 feet above sea level. *Access*, via the Chicago, Burlington & Quincy Railway and connections, with good schedules; thence by motor over good macadam highways, leading through a rough and rugged mountainous region full of picturesque natural beauty and mountain grandeur, 3 miles to the springs. *Hotel*, there are ample accommodations—a good resort hostelry with detached cabins and a modern bathing establishment, open May to November for the past thirty-five years. There are 5 springs in this area, of which we present herewith the analysis of the most important spring, which shows the mineralization:

DE MARIS NEEDLE BATH SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. J. Frankforter). |
|---|---|
| Potassium chloride (KCl) | 17.14 |
| Sodium chloride (NaCl) | 47.08 |
| Potassium sulphate ($K_2SO_4$) | 94.02 |
| Magnesium sulphate ($MgSO_4$) | 396.02 |
| Calcium sulphate ($CaSO_4$) | 171.04 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 1410.38 |
| Lithium bicarbonate ($LiHCO_3$) | 10.50 |
| Potassium bicarbonate ($KHCO_3$) | 76.45 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | 26.45 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 15.26 |
| Silica ($SiO_2$) | 26.50 |
| Total solids | 2290.84 |
| Flow in gallons per day | 240,000 |

Medicinal classification, weak alkaline b4, weak sulphated or (−Ab4, −S). This is a moderately highly mineralized, calcic, bicarbonated and magnesic, calcic sulphated alkaline-saline (ferruginous) water, slightly sulphuretted and moderately highly sulphated. This water possesses diuretic, antacid and laxative properties. Its administration promotes the secretions of the digestive tract, increases the activity of the renal and vesical organs.

This water has been found useful in the treatment of rheumatism, gout and the uric-acid diathesis. The sulphate radicle present in solution aids in stimulating the secretions of the mucous membranes of the intestinal tract and also stimulates the hepatic function. The waters have been found useful in the treatment of skin diseases, in dropsical conditions, obesity and in incipient Bright's disease, etc.

## Paulson Medicinal Well.

*(Carbon County.)*

*Postoffice,* Saratoga. *Location,* in midsouthern Wyoming; west of Cheyenne, the capital city, 120 miles; north of Glenwood Springs, Colo., 140 miles; south of Rawlins, 30 miles. *Situation,* in the Saratoga Valley, north of the Platte River, at an elevation of about 8000 feet above sea level. *Access,* via the Union Pacific Railway. *Hotel,* no provision made to entertain guests, but good hotels in the town. The water, on analysis, shows the following mineralization:

PAULSON MEDICINAL WELL.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, N. F. Harriman). |
|---|---|
| Magnesium chloride ($MgCl_2$) | trace |
| Magnesium sulphate ($MgSO_4$) | 45.31 |
| Calcium sulphate ($CaSO_4$) | 149.45 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 16.89 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 291.70 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 2.22 |
| Silica ($SiO_2$) | 56.94 |
| Total solids | 562.51 |
| Radio-activity, Mache units per liter | 3.59 |

Medicinal classification, weak total mineralization or (−T), weak radio-active. This is a moderately mineralized, calcic, magnesic, bicarbonated and sulphated alkaline (ferruginous) water, carbon-dioxated, radio-activated, possessing slight laxative, diuretic, antacid and tonic properties. The water is endorsed by the profession as a valuable adjuvant in the treatment of various forms of stomach, bladder, kidney and liver disorders, biliousness, jaundice, rheumatism and the uric-acid diathesis. The waters have been bottled and shipped extensively since 1911.

## Washakie Hot Springs.

(*Fremont County.*)

*Postoffice*, Shoshone Indian Agency, Ft. Washakie. *Location*, west of central Wyoming, in the Shoshone Indian Reservation; southwest of the Yellowstone National Park, 120 miles; northwest of Cheyenne, the capital city, 240 miles. *Situation*, on little Wind River, among the eastern foothills of the Wind River Mountains, at an elevation of 5600 feet above sea level. *Access*, via the Chicago & Northwestern Railway System to Lauder, thence by motor over a mountainous macadam highway, leading through a wonderful picturesque region, 18 miles to the springs. *Hotel*, accommodations primitive. The bath-house is old, with separate divisions for male and female bathers. There are a few private rooms for guests. The analysis shows the following mineralization:

WASHAKIE HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, C. H. Badger). |
|---|---|
| Potassium chloride ($KCl$) | 32.0 |
| Sodium chloride ($NaCl$) | 46.0 |
| Sodium sulphate ($Na_2SO_4$) | 65.0 |
| Magnesium sulphate ($MgSO_4$) | 178.0 |
| Calcium sulphate ($CaSO_4$) | 251.0 |
| Sodium nitrate ($NaNO_3$) | 14.0 |
| Sodium arsenate ($Na_2HAsO_4$) | trace |
| Lithium bicarbonate ($LiHCO_3$) | 2.5 |
| Strontium bicarbonate ($Sr[HCO_3]_2$) | trace |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 373.0 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | 0.8 |
| Silica ($SiO_2$) | 46.0 |
| Total solids | 1008.3 |
| Temperature, °C. | 43.3 |
| Gas: | |
| Hydrogen sulphide | 0.9 |

Medicinal classification, weak alkaline b, weak calcic sulphated or (−Ab, −CaS), thermic. The analysis shows this to be a moderately mineralized, thermic, calcic and magnesic sulphated and calcic bicarbonated, alkaline-saline (lithic, ferruginous) water, sulphuretted. This water possesses diuretic, laxative, alterative and tonic properties. This water should be valuable in the treatment of digestive disturbances due to acidity; the sulphate radicles are present in solution in sufficient amounts to induce laxative action of the bowels. The calcium sulphate and lithia give the water diuretic and some slight solvent action, and the waters should be useful in irritable conditions of the renal and vesical apparatus. Hot baths administered with this water has given relief in chronic rheumatism and rheumatic arthritis, in obstinate skin affections and in all types of chronic joint disturbances.

## Yellowstone National Park.

*(Government Reservation.)*

*Postoffice*, Yellowstone National Park. *Location*, in the extreme northwestern corner of the state; west of St. Paul, Minn., 1000 miles; east of Portland, Ore., 1000 miles; west of Chicago, Ill., 1500 miles; east of San Francisco, Calif., about 1500 miles. *Situation*, in the heart of the Rocky Mountains. Its area comprises more than 5000 square miles of territory, being 54 miles across from east to west and 62 miles from north to south. In 1872 an Act of Congress was passed, setting aside forever this area of territory as a public park. The park is an elevated plateau basin, with a mean altitude of 8000 feet above sea level, and is surrounded on all sides by lofty, snow-capped and extremely rugged mountain ranges. We cannot, in our limited space attempt a description of the scenic wonders of this wild, weird, picturesque region of rugged mountains; craggy peaks, snow capped and dazzling; woodland and meadow, with wild rushing mountain streams, mountain torrents, leaping cascades, placid lakes and the hissing steaming geysers and appalling canyons; we could write volumes and leave the story half untold. *Access*, via the Southern Pacific Railway to Livingston, Mont., on the northern border of the park, thence by motor transportation, 7 miles to Mammoth Hot Springs. *Hotels*, the Park Association conducts hotels in the park under franchises issued by the United States Government.

The Yellowstone National Park is the most widely known of all our national parks, because it contains more geysers than all the rest of the world together; the only other two places where geysers exist are in Iceland and New Zealand. To get an idea of the enormity of the handiwork of the Great Architect who formed the geology of this area, we must begin with its making. The entire region is of volcanic origin. The mountains around it on both sides and the mountains within it are the products of remainders of great volcanoes which belched forth seething red hot lava in the dim and distant past; the great plateaus, from which arise its geysers and hot springs, and through whose forests now roam so many wild animals, are composed of the ash and disintegrated lava which once were ejected from eruptive seething volcanoes.

The petrified forest of Specimen Ridge affords an interesting and fascinating glimpse of Yellowstone's tempestuous past. Here may be seen many levels of upright, petrified trunks, alternating with layers of lava, simulating the layers of a layer cake; this plainly shows that after the first forest grew on the volcano's slope, and was engulfed by a fresh run of lava, enough time elapsed for a second forest to grow upon that level, and that this in turn was engulfed with new lava to make the level for another forest and so on. There is a cliff 2000 feet high, composed wholly of these alternate levels of engulfed forests and the lava which engulfed them. The first recorded visit of a

white man to this area was made by John Colter, on his return home from the Lewis-Clark Expedition, in 1810. In 1829 Joseph Meek wandered into the area while trapping for game, recorded his description of it as "A country smoking with vapor from boiling springs and burning with gases issuing from small craters." From some of the craters, he affirmed, "issued blue flame and molten brimstone," which, of course, was a play of the imagination, though doubtless Meek fully believed it to be true.

The thermic waters of this area are classified by Arnold Hague as: (1) Calcareous waters, carrying relatively large amounts of calcium bicarbonate in solution; (2) silicious acid waters, which usually carry free acid in solution and possess an astringent taste (silicious alkaline waters. The Mammouth Hot Springs is the only important group of calcareous waters in the park. In the course of their circulation in the nether world they pass through Jurassic and Cretaceous limestones and become charged with carbon dioxide and mineral matter, which is deposited as travertine. Acid waters occur in the following localities: Norris Basin, Shoshone Basin, Heart Lake Basin, Tower Falls, Mount Washburn, mud volcanoes and other places. Alkaline waters predominate in the regions of geyser activity. These waters deposit an incrustation of amorphous silica. There are about 4000 springs in the park and about 100 geysers. A few of the springs are cold, but the great majority are hot, many of which are highly mineralized. We give below a few analyses:

YELLOWSTONE NATIONAL PARK HOT SPRINGS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Geol. Survey). | | | | | |
|---|---|---|---|---|---|---|
| | Mammoth Hot Springs. | | | | | |
| | Cleopatra Spring. | No. 17 Spring. | Orange Spring. | Soda Spring. | Coral Spring. | Hygiene Spring. |
| Ammonium chloride ($NH_4Cl$) | ... | ... | ... | 1.50 | 1.2 | 0.60 |
| Lithium chloride (LiCl) | ... | ... | 9.70 | ... | 12.1 | 19.40 |
| Potassium chloride (KCl) | ... | ... | 116.50 | 5.10 | 139.3 | 359.40 |
| Sodium chloride (NaCl) | 239.38 | 323.19 | 163.60 | 1.50 | 1001.1 | 29.40 |
| Magnesium chloride ($MgCl_2$) | ... | ... | ... | ... | 1.6 | |
| Ferric chloride ($Fe_2Cl_6$) | ... | ... | ... | ... | trace | |
| Potassium bromide (KBr) | ... | ... | trace | ... | ... | trace |
| Aluminum chloride ($Al_2Cl_6$) | ... | ... | ... | ... | 14.1 | |
| Sodium sulphate ($Na_2SO_4$) | 607.50 | 587.72 | 183.40 | 10.20 | ... | 34.80 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | ... | ... | trace | |
| Magnesium sulphate ($MgSO_4$) | ... | ... | 329.50 | 50.00 | 9.0 | |
| Potassium sulphate ($K_2SO_4$) | trace | | | | | |
| Calcium sulphate ($CaSO_4$) | 320.85 | trace | 202.20 | ... | 34.7 | |
| Ferrous sulphate ($FeSO_4$) | ... | ... | ... | ... | ... | trace |
| Sodium biborate ($Na_2B_4O_7$) | ... | ... | ... | ... | ... | 34.50 |
| Disodium arsenate ($Na_2HAsO_4$) | ... | ... | ... | ... | 0.7 | 4.90 |
| Boron trioxide ($B_2O_3$) | ... | ... | ... | ... | 32.8 | |
| Sodium bicarbonate ($NaHCO_3$) | ... | 485.66 | ... | ... | ... | 464.85 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 211.41 | 64.49 | ... | 3.55 | ... | 13.82 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 688.40 | ... | 903.96 | 327.24 | ... | 25.92 |
| Ferric oxide and alumina ($Fe_2O_3$, $Al_2O_3$) | ... | ... | 2.20 | 8.40 | ... | 6.80 |
| Silica ($SiO_2$) | 59.85 | 61.56 | ... | 18.40 | 60.7 | 247.70 |
| Total solids | 2127.39 | 1522.62 | 1911.06 | 425.89 | 1307.3 | 1243.09 |
| Temperature, °C. | 71.1 | 70.2 | 63.3 | 5.8 | 72.8 | 42.8 |
| Gases: | | | | | | |
| Uranium, gm. | none | none | none | 3.2 | none | trace |

YELLOWSTONE NATIONAL PARK HOT SPRINGS—*Continued*).

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Geol. Surv.). | | | | | |
|---|---|---|---|---|---|---|
| | Madison Spring. | Asta Spring. | Bench Spring. | Chrome Spring. | Soda Butte Spring. | Alum Creek. |
| Ammonium chloride ($NH_4Cl$) | 2.40 | ... | ... | 31.5 | 16.90 | 3.10 |
| Lithium chloride (LiCl) | 2.40 | 4.80 | ... | 38.8 | trace | 5.50 |
| Potassium chloride (KCl) | 73.50 | 22.10 | ... | 306.2 | 42.50 | 66.90 |
| Sodium chloride (NaCl) | 51.30 | 132.00 | ... | 1353.6 | | |
| Potassium bromide (KBr) | ... | ... | ... | trace | ... | trace |
| Sodium sulphate ($Na_2SO_4$) | 21.80 | 57.50 | 177.2 | 580.4 | 106.20 | 492.40 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | 6.6 | ... | ... | 15.80 |
| Magnesium sulphate ($MgSO_4$) | ... | ... | trace | 10.0 | ... | 19.00 |
| Potassium sulphate ($K_2SO_4$) | ... | ... | 21.6 | ... | 3.40 | 87.20 |
| Calcium sulphate ($CaSO_4$) | ... | ... | trace | 47.6 | ... | 43.20 |
| Ferrous sulphate ($FeSO_4$) | ... | ... | ... | ... | ... | 89.30 |
| Sodium biborate ($Na_2B_4O_7$) | 18.70 | trace | ... | 51.6 | 21.60 | trace |
| Disodium arsenate ($Na_2HAsO_4$) | trace | trace | ... | 7.6 | | |
| Boron trioxide ($B_2O_3$) | ... | ... | ... | 48.5 | ... | 5.70 |
| Sodium bicarbonate ($NaHCO_3$) | 954.90 | 231.87 | ... | ... | 66.40 | |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | 10.43 | 6.08 | ... | ... | 384.45 | |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 103.36 | 47.79 | ... | ... | 941.70 | |
| Aluminum oxide ($Al_2O_3$) | ... | 11.20 | 26.3 | 8.2 | 13.10 | |
| Ferric oxide ($Fe_2O_3$) | ... | ... | ... | ... | ... | trace |
| Silica ($SiO_2$) | 15.70 | 165.00 | 240.0 | 375.0 | 33.50 | 218.00 |
| Total solids | 1254.49 | 677.84 | 271.7 | 2859.0 | 1629.75 | 1097.12 |
| Temperature, °C. | 60 | 86.6 | 88.2 | 92 | 18 | 22.3 |
| Gases: | | | | | | |
| Uranium, gm. | none | none | 366.0 | none | none | none |
| Water g × 10-4U activity | none | 8.45 | 6.4 | none | none | none |

Cleopatra Spring, medicinal classification, weak alkaline b3, weak sulphated 2 or (−Ab3, −S2), thermic.

Spring No. 17, medicinal classification, weak alkaline a, weak sulphated or (−Aa, −S), thermic.

Orange Spring, medicinal classification, weak alkaline b2, weak sulphated 2 or (−Ab2, −S2), thermic.

Soda Spring, medicinal classification, weak total mineralization or (−T), radio-activated.

Coral Spring, medicinal classification, weak saline 3 (arsenic) or (−Cl 3 [As]), thermic.

Hygiene Spring, medicinal classification, weak alkaline a, weak saline (arsenic) or (−Aa, −Cl [As]), thermic.

Madison Spring, medicinal classification, weak alkaline a3 or (−Aa3) thermic.

Asta Spring, medicinal classification, weak total mineralization (−T2), thermic, radio-activated.

Bench Spring, medicinal classification, thermic, radio-activated.

Chrome Spring, weak saline 4, weak sulphated (arsenic) or (−Cl4, −S [As]), thermic.

Soda Butte Spring, medicinal classification, weak alkaline b3 or (−Ab3).

Alum Creek Spring, medicinal classification, weak sulphated, very weak ferruginous or (−S, − −Fe).

The Yellowstone National Park is in a class all alone when we consider the number and variety of its hot springs, and, on account of the great number and variety of its thermic waters and great number of geysers, it may become one of the greatest spas in the world. There are more than 4000 springs, of which perhaps less than 100 have been carefully analyzed. When the waters are better known and more carefully studied, from clinical application, they will undoubtedly be more highly prized for their medicinal virtues. Practically all the analyses that have been made of the waters in the park were made by Gooch & Whitfield (*Bull.* No. 47, U. S. Geol. Surv.). A glance at the analyses will show that the mineral constituents consist chiefly of calcium, sodium, magnesium, potassium, lithium, silicon dioxide, sulphur trioxide, chlorine and basic oxygen. The following ingredients have been found in small quantities or traces: Arsenic, bromine, aluminum, boron, manganese, barium, strontium, rubidum, ammonium, hydrogen sulphide, phosphorus and hydrochloric and silicic acids. In 1909 the radio-activity of the waters studied by Schlundt & Moore (*Bull.* No. 395, U. S. Geol. Surv.) was found to be highly radio-activated. Many of the waters contain free carbonic acid and hydrogen sulphide.

The muriated acid springs, so far as shown by analyses, are, with one exception, to be found in this country at Yellowstone National Park. The Lemonade Spring at the Geysers in California contains free hydrochloric acid, 2.03 parts per 1,000,000, and free sulphuric acid, 544.12 parts per 1,000,000. Waters containing free silicic acid are found at a number of localities in the United States, but are most numerous in the springs at Yellowstone National Park. The quantity of silicic acid ranges from 11 to 50 per cent; the average, however, is about 25 per cent. A number of the springs in the park fall into the class of sulphated acid and muriated acid; there is also usually present a large percentage of free silicic acid. One such spring is the Bench Spring in the Upper Geyser Basin, which contains 50.88 per cent of silicic acid and only traces of sulphuric acid. This spring is a sodic sulphated acid water.

*Geysers* are, roughly speaking, water volcanoes. They occur only at places where the internal heat of the earth approaches close to the surface. Their action, for so many years unexplained, and even now regarded with wonder by so many, is simple. Surface water percolating through the crust of the earth or through cracks in the rocks, or water from subterranean sources collecting at the bottom of the geyser's crater, down, deep in the strata of seething white hot lava, becomes immediately intensely heated and gives off steam, which expands and forces upward the cooler water that lies above. The water at the surface of the geyser begins to bubble and shortly gives off clouds of steam, indicating that the geyser is about to go into action. After a time the water in the bottom of the geyser, under the con-

tinued heat below and the water above getting warmer, suddenly bursts upward with great violence, shooting many feet into the air and continuing to play until all the water in the crater has been expelled. Spring water, or the same water cooled and falling back, by and by again reaches the nether world in greater or less time, according to difficulty in the way of its return, becomes reheated to the boiling point and again is spouted forth from the geyser's opening.

YELLOWSTONE NATIONAL PARK GEYSERS.

| Hypothetical combinations. | Parts per 1,000,000 (Analyst, U. S. Geol. Surv.). | | | | |
|---|---|---|---|---|---|
| | Fearless Geyser. | Pearl Geyser. | Constant Geyser. | Old Faithful Geyser. | Giantess Geyser. |
| Ammonium chloride ($NH_4Cl$) | 0.70 | 0.60 | 3.8 | trace | trace |
| Lithium chloride (LiCl) | 49.20 | 13.30 | 18.2 | 34.00 | 34.60 |
| Potassium chloride (KCl) | 76.80 | 103.90 | 142.3 | 5.10 | 78.30 |
| Sodium chloride (NaCl) | 976.00 | 973.80 | 759.0 | 639.30 | 617.30 |
| Ferric chloride ($Fe_2Cl_6$) | ... | ... | trace | | |
| Potassium bromide (KBr) | 3.90 | ... | ... | 4.78 | trace |
| Sodium sulphate ($Na_2SO_4$) | 40.40 | 36.60 | 63.5 | 27.00 | 29.60 |
| Aluminum sulphate ($Al_2[SO_4]_3$) | ... | ... | 30.4 | | |
| Magnesium sulphate ($MgSO_4$) | 0.50 | ... | 9.0 | | |
| Calcium sulphate ($CaSO_4$) | 23.00 | 3.70 | 49.6 | | |
| Ferrous sulphate ($FeSO_4$) | ... | ... | trace | | |
| Sodium biborate ($Na_2B_4O_7$) | 31.90 | 39.40 | ... | 21.30 | 33.60 |
| Disodium arsenate ($Na_2HAsO_4$) | 2.90 | 5.10 | 1.8 | 2.70 | 0.80 |
| Boron trioxide ($B_2O_3$) | ... | ... | 31.7 | | |
| Sodium bicarbonate ($NaHCO_3$) | ... | ... | ... | 330.92 | 2.69 |
| Magnesium bicarbonate ($Mg[HCO_3]_2$) | ... | 5.48 | ... | 3.65 | 7.30 |
| Calcium bicarbonate ($Ca[HCO_3]_2$) | 9.88 | 21.55 | ... | 3.65 | 317.35 |
| Aluminum oxide ($Al_2O_3$) | 0.40 | 5.90 | ... | 1.70 | 9.30 |
| Silica ($SiO_2$) | 418.00 | 463.80 | 468.5 | 369.10 | 391.70 |
| Total solids | 1633.58 | 1673.13 | 1577.8 | 1443.20 | 1523.54 |
| Temperature, °C. | 89.9 | 86.7 | 92.2 | 88.9 | 93.2 |

Fearless Geyser and Pearl Geyser, medicinal classification, weak saline 3 (arsenic) or (−Cl 3 [As]), thermic.

Constant Geyser, Old Faithful Geyser and Giantess Geyser, medicinal classification, weak saline 2 (arsenic) or (−Cl 2 [As]), thermic.

The geysers are confined to three basins lying near each other, in the middle west section of the park, but other hot-water manifestations appear at widely separated points. A tour of these hot-water formations and spouting geysers is an experience never to be forgotten. Some of the geysers go into action at regular intervals and with regular intervals of eruption, as will be seen from the following table:

ACTIVITIES OF THE YELLOWSTONE NATIONAL PARK GEYSERS.

| Name of geyser. | Eruption, feet. | Duration of eruption. | Intervals. |
|---|---|---|---|
| Black Growler | 10 to 12 | Continuous | |
| Hurricane | 10 to 12 | 30 minutes | 5 minutes. |
| Monarch | 100 | ... | Varies. |
| Fountain | 20 to 30 | ... | 1 minute. |
| Great Fountain | 60 to 80 | 1 hour | Frequent. |
| Old Faithful | 150 | 6 minutes | 1 hour. |
| Bee Hive | 200 | 8 minutes | 5 times a week. |
| Giantess | 125 | 10 to 12 hours | 14 days. |
| Lioness | 100 | 12 minutes | 24 to 48 hours. |
| Grand | 200 | 30 minutes | 15 to 20 hours. |
| Giant | 250 | 90 minutes | 5-day interval. |
| Splendid | 200 | 8 minutes | 3 days. |
| Castle | 100 | 50 minutes | 24 to 30 hours. |

This great park, with its great variety of highly mineralized, thermic waters, is destined to become a popular health resort and spa. If this property were developed and improved it would be a mecca for tourists and for those seeking to regain their health. It is expected that the time will come when these waters will be used extensively in practical therapeutics.

The following springs were once used as resorts:

*Alcova Hot Springs, P. O.*, Alcova, Matrona County. The location is 35 miles southwest of Casper. The surrounding country abounds in picturesque scenery. The Fremont Canon, where the springs gush out from the base of a rock, is 700 feet in height. We learn that extensive improvements have been made in hotels and bath-houses, but no definite information nor satisfactory analysis available.

*Hot Springs, P. O.*, Hailey. A few miles off the road, between Lander and Rawlins. From what information we could gather, this spring is a sulphur spring, having a composition similar to the Ft. Washakie Hot Springs and a temperature of 100° to 200° F. The flow is probably in the neighborhood of 100 to 200 gallons per minute. At the present time it is not used for any purpose besides irrigation.

*Hot Springs, P. O.*, Fremont Butte, Sublette County. In T. 32 N.,. R. 107 W. Information concerning these springs is very meager Small bath-houses have been erected and the springs are used for bathing purposes by the residents of that locality.

*Hot Springs on the Snake River.* This spring is situated on the east side of the Snake River, in a meadow of about 50 acres extent, about 20 miles south of Jackson and about 4 miles below the junction of the Hoback River and Snake River, from which point it is necessary to travel by horseback to reach the spring. It is a sulphur spring coming through the red beds of the Chugwater formation. It has a temperature of from 100° to 200° F. A small log cabin has been erected over the spring for a bath-house. The flow of the spring has not been measured, but has been estimated to be 100 gallons or

more per minute. It is used by residents of that locality, and is said to be good for rheumatism. Water is used to a limited extent for irrigation and is valuable for that purpose, as crops can be grown earlier in the spring and later in the fall than on lands where cold water is used.

*Rawlings Sulphur Spring, P. O.*, Rawlins, Carbon County. These springs are situated 2 miles from Rawlins, upon an elevated plateau about 6400 feet above sea level. Hotels and cottages. No definite information for satisfactory analysis available.

There are a number of other springs in various parts of the state which have not been investigated, mainly by reason of their being too remote from transporation.

## CHAPTER XV.

## THE GREATER AMERICAN SPAS.

During the recent past there has been broadcasted, as it were, a revival of interest on the part of the medical profession in mineral water therapy and spa treatment in general. This renewed interest in crounotherapy is encouraging, for we have in our own country every variety of mineral water found in other parts of the world, and without fear of contradiction we can safely assert that our American waters are just as good, just as potent, just as efficacious, and not only equal to any in the world, but in some instances, superior.

One reason for this state of affairs is that our American medical schools have shown little or no inclination to give instruction in the science of crounotherapy and balneotherapy. It is pleasing to note that the attitude of the profession toward mineral-water treatment has appreciably changed. The careless apathy and indifference of past years is giving place to active and serious interest in the science of hydrology. The fact that this renewed interest is sponsored by those who stand highest in the profession—leaders and moulders—of medical thought, assures the recognition and establishment of hydrology on a scientific basis.

Many of the greater spas in the United States have been and are expending vast sums of money in the construction and equipment of bathing establishments, most of which in many particulars excel any similar establishment in foreign countries. They have for their medical directors eminent physicians who have mastered the science of hydriatics in general, so that it is no longer necessary for American physicians to subject their patients to long, tedious, expensive and, in many instances, hazardous sea voyages to secure treatment at a foreign mineral spring or spa. It is a serious reflection on the profession and on our American spas that so many thousands, even hundreds of thousands, of patients have spent small fortunes, hunting health abroad, when they could have had the same treatment, and more considerate care, at home, for a fraction of the cost.

There are now scores of spring resorts throughout the country offering every comfort for the invalid, while the greater American spas described in this chapter offer all the comforts of a home, all the service of the best hotel and all the advantages of the best sanitarium, with every comfort, convenience and luxury to be had at any spa in the world. Europeans get relief at their home spas, and we should at ours. Change of scene and travel are just as beneficial and invigorating here as in Europe, and this *great country of ours, stretching from Canada to Mexico, and from the Atlantic to the Pacific Oceans, contains scenic effects as interesting as any in Europe.*

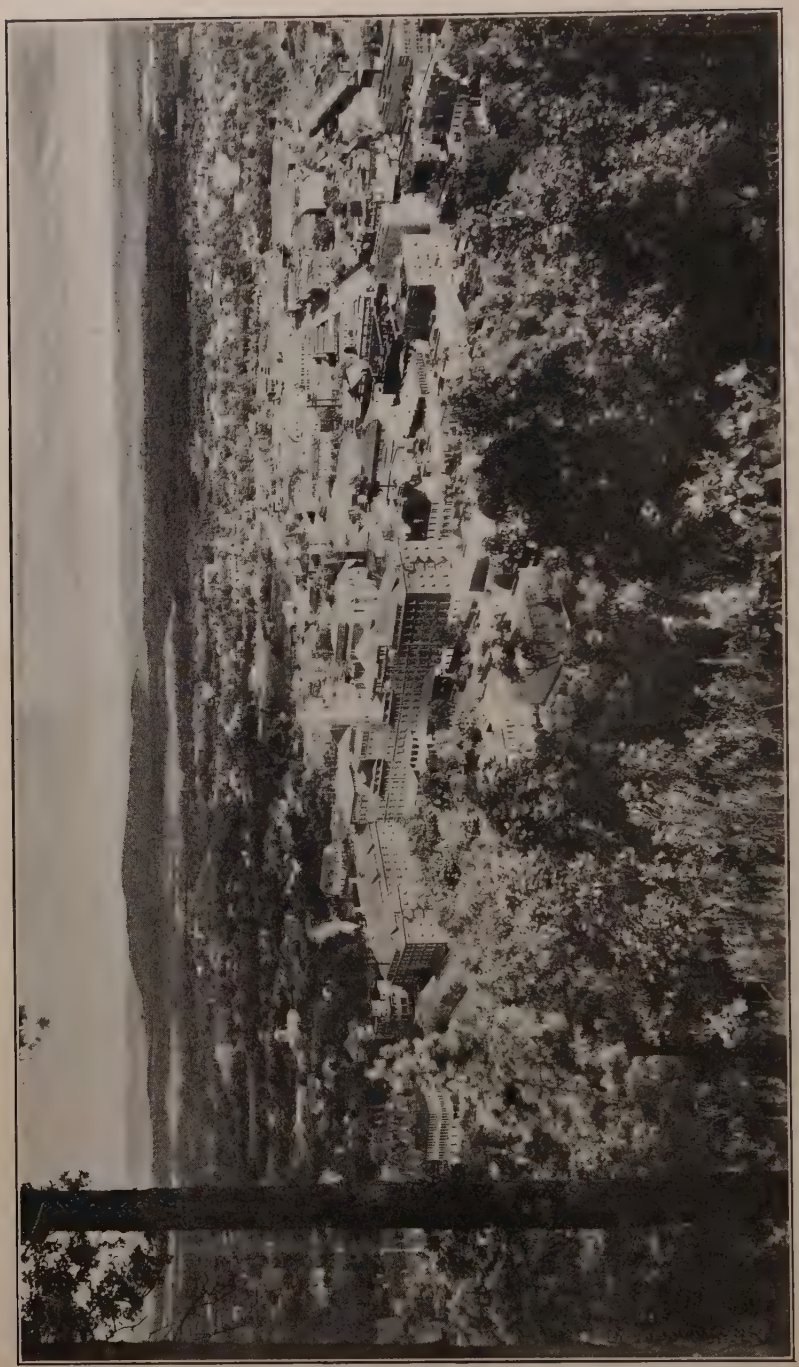


FIG. 11.—Bird's-eye view of Hot Springs National Park, Hot Springs, Ark.

## Hot Springs National Park.

(*Hot Springs, Ark.*)

*Historical.*—Hot Springs has been famous since the lower Mississippi Valley was first settled. Legend tells that Ponce de Leon sought the Fountain of Youth in the Ozark region as early as 1512, while De Soto and his band of explorers reached the magic spot in 1541.

*The Springs.*—The springs, 46 in number, have an aggregate daily flow of 851,308 gallons and gush from the base of Hot Springs Mountain. Hot Springs, a city with a population of 20,000, has been built about the springs and is one of the principal health and pleasure resorts of the nation. Federal statistics show that Hot Springs National Park was the most popular of all the 19 government-owned reservations during the year 1925 with the American traveling public, having been visited by an excess of 265,000 people during that period.

*Action of the Waters.*—The hot waters are indicated and expected to give relief in chronic diseases when the elimination is defective, or when it is desired to increase elimination of poisonous products from the various excretory organs. Relief is often given in rheumatic and gouty conditions, neuralgias, neuritis and allied disorders; in the early stages of Bright's disease; in many chronic skin diseases; in certain forms of anemia; and in some forms of cardiovascular disease with high blood-pressure.

*Bathing Establishments.* There are 20 bath-houses under the rules and regulations approved by the Secretary of the Interior. These establishments are acknowledged to be the equal if not the superior of any similar bathing establishments in the world.

The baths create a reaction accompanied by an elevation of body temperature, accelerated heart action with diminished blood-pressure in the arteries and a stimulation of the nutritive changes in the tissue cells, especially those composing the organs of elimination and those concerned in the formation of the blood. Just why this reaction occurs has not been definitely determined, but it does occur regularly, and the department is now interested in experiments to determine just why these waters differ so markedly from ordinary waters. The mineral constituent is very low and when the waters are taken internally, combined with the sweating produced by the baths and packs, elimination by all the emunctories is greatly increased. In syphilis the baths have a marked influence by permitting greater quantities of specific medicines to be ingested and eliminated.

*Professional Supervision.* The only physicians allowed to prescribe the waters of the Hot Springs are those licensed practitioners of the state of Arkansas, who have been examined by the Federal Board of Examiners appointed by the Secretary of the Interior. The medical directors of the bathing establishments are professional men of high attainments and experts in hydriatic practice.

The Manitou Bath, Manitou, Colo.

FIG. 12.—The Cliff House, Manitou, Colo. Overlooking Soda Springs Park, with Pike's Peak in the background.

## The Cure at the Springs of Manitou.

(*Colorado.*)

*Location.*—Manitou Springs are situated in a cleft of the great Rocky Mountains at the foothills of Pike's Peak, near the entrance to the Garden of the Gods.

*Climatic Conditions.*—The winter temperature varies from 8.9° to 13.3° C. (48° to 56° F.), giving a climate cool in summer and not too cold in winter. The high altitude insures a dry, pure atmosphere, ozone-laden, with a tang of the forests, tending to arouse physical energy and mental activity.

*The Manitou Springs.*—The effects of the mineral constituents held in solution is readily understood from the knowledge of the accepted action of salts formed from the hypothetical combinations of the various elements found on analysis.

*Radio-activity.*—These waters are highly radio-active, which endows them with energizing properties, stimulating to cell activity, promoting rapid absorption and increasing glandular function. The carbonic-acid gas, likewise radio-active, is powerfully stimulating internally through the direct chemical, physical, mechanical and reflex effects which it induces.

*Uses of the Waters.*—The waters are more effective at the springs, since radio-activity and carbonization are greatest as the waters pour forth at their sources. In health they are permissible at all times. In the sick chamber they are pleasing to the palate and acceptable to the most delicate stomach. In functional derangements of the stomach these waters find a wide range of usefulness, hyperacidity is overcome and fermentation allayed. In dilatation and motor insufficiencies of the stomach the water has given great satisfaction. The waters are especially indicated and used with success in gastric ulcer. In systemic disorders, such as diabetes, incipient Bright's disease, engorgements of the liver, the anemias and disorders due to an excess of uric acid in the blood and tissues, the results are pleasing.

*Bathing Establishments.*—The Manitou Bath-house, beautiful, commodious and ornate, is built right over the original soda-encrusted springs. It is modern in construction and equipment, including the most approved devices for administration of the Turkish, Roman, Vichy, continuous-flow, Scotch douche, sitz and all other baths. There are also the needle and fan sprays, tubs, showers, appliances for irrigation and internal baths, electric, hot-air and vapor cabinets.

Every facility is provided to make the fullest use of the emanations from the radio-activity of the original Manitou Soda Springs. It has been found that these baths afford a wonderful degree of comfort and relief from many ailments, including rheumatism and chronic articular disorders, lumbago, sciatica, neuritis, chronic skin disorders, sub-acute arthritis, incipient arteriosclerosis, gout, obesity, neurasthenia, etc.

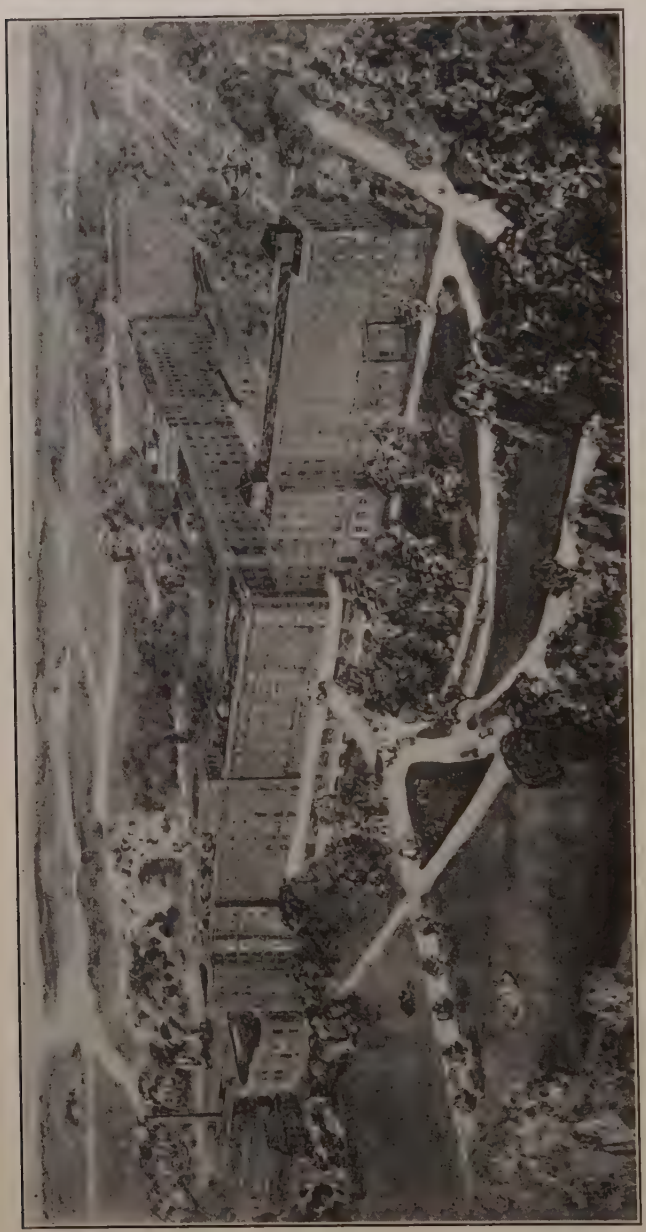


FIG. 13.—French Lick Springs Hotel and grounds.

## French Lick Springs.

(*French Lick, Ind.*)

*Historical.*—Nearly two hundred years ago a French trading-post was established at French Lick, hence the name by which this resort is known today.

*Location.*—In southern Indiana, in the "Lost River Valley," through which flows French Lick Creek, between rugged hills. Because of its rugged nature, the adjoining country retains much of its primitive wildness.

*Climate.*—The climate is that of the lower Ohio River Valley, with an elevation of 500 feet above sea level; the atmosphere is neither too bracing nor too enervating. According to the United States Weather Bureau, the spring temperature is 12.2° C. (54° F.); summer temperature is 24.4° C. (76° F.); autumn temperature is 13.3° C. (56° F.); winter temperature is 1.1° C. (34° F.). The autumn is delightful, frequently lasting into December. The winters, while bracing, are crisp and invigorating. The summer season has many hot days, incident to this latitude.

*The Springs and Mineralization.*—The 3 springs in this area are of the sulphated alkaline-saline type of waters, sulphuretted and radio-activated. The waters are all cool, and have a strong odor of sulphuretted hydrogen and a slightly bitter taste due to the magnesium and sodium sulphate content of the mineralization.

*Radio-activity.*—The waters of the 3 French Lick Springs have been carefully tested by Herman Schlundt, Professor of Physical Chemistry at the University of Missouri, and found to be charged with active radium emanations. This attribute of certain mineral waters has only been recognized in recent years, but much work has been done with it along clinical lines. It has been shown by incontestable authority that much of the efficacy of many mineral waters is due to radio-activity. This explains in part the better results obtained from natural waters as compared with those artificially compounded. The most striking effects of the radio-active waters are shown in the treatment of gouty arthritis and neuritis, irregular forms of gout, muscular rheumatism and arterial hypertension. Monosodium urate, the more insoluble salt of uric acid, is believed to be converted in the tissues by radium emanation into a more soluble form which is eliminated with less difficulty. These recent discoveries account in part for the striking improvement obtained at French Lick in many cases of the above-mentioned disorders.

*Physiological Action of the Waters.*—These waters exert laxative, diuretic and antacid action. Physiologically, they promote interchange of fluids and salts in the tissues, modifying secretions and excretions and stimulate oxidation and cellular activity. They increase elimination through the intestinal canal, kidneys and skin.

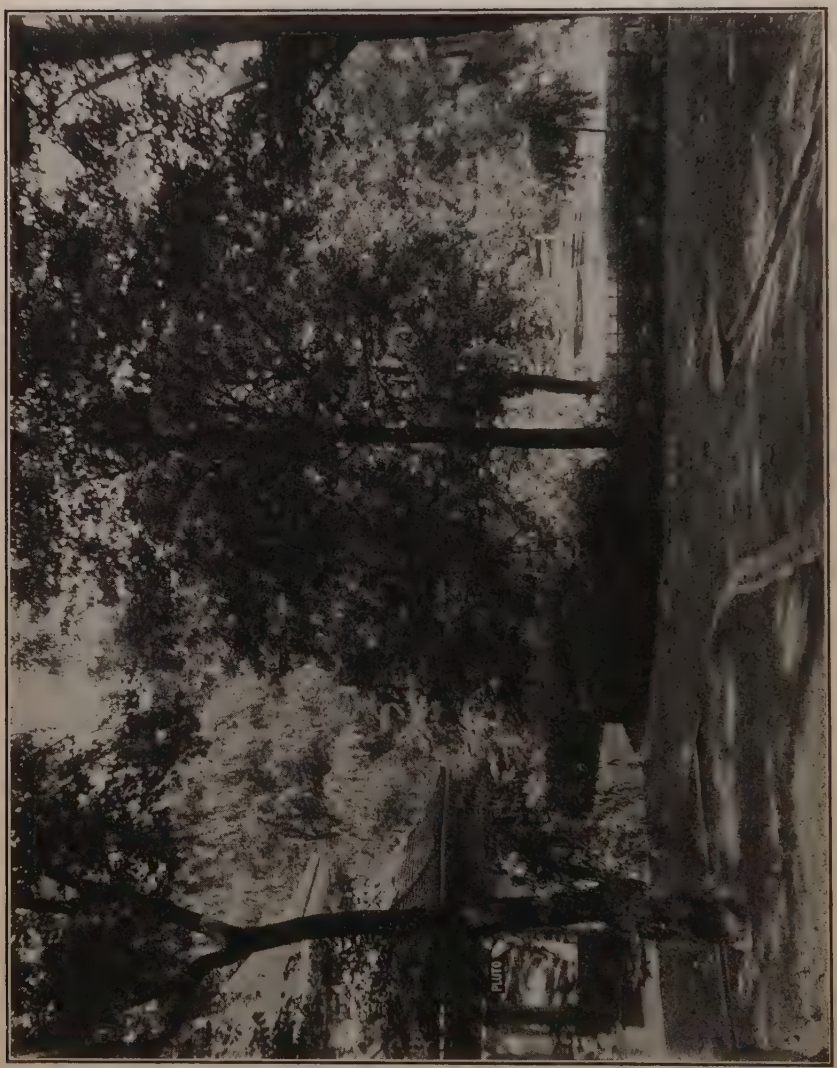



FIG. 14.—Entrance to Pluto Spring (on left); a part of Japanese garden (on right).

Mechanically, they promote contraction and movement in the large and small intestines, removing the toxic products of fermentation and food decomposition. The stimulation of liver function and circulation is due partly to the removal of these products from the splanchnic circulation and partly to the action of the absorbed salts upon liver cells.

The action of these waters retards the absorption of the end-products (poisons) of protein metabolism. The action on the kidneys directly increases the volume of the urine by salt action on the secreting cells and on the capillaries of the glomeruli. This increased diuresis eliminates nitrogenous waste in the shape of urea and uric acid, renders the urine less acid and irritating and less likely to deposit oxalates, uric acid and urates, and thus inhibits the possibility of stone formation.

*Clinical Indications.*—These natural waters are widely known for their potent therapeutic properties. The waters have been found useful in the following diseased conditions: Diseases of the stomach; diseases of the intestines; diseases of the liver; diseases of the gall-bladder and ducts; autointoxication; intestinal indigestion; diseases of nutrition; rheumatism, diabetes, obesity, diseases of the blood and bloodvessels; diseases of the urinary system, and diseases of the skin.

*Bathing Department.*—The balneotherapeutic departments for men and women are on the first and second floor, respectively, and connected directly with the ground and second floors of the south wing of the hotel, conveniently reached by elevator from any part of the establishment. The construction and equipment of the bathing department is modern in all of its details, including the latest scientific equipment for the practice of hydrotherapy and balneotherapy in all its branches, viz: sulphur, electric-light, Turkish, Russian, Nauheim, Aix and Vichy baths, special control tables for giving the Scotch, needle and rain douche.

The baths are administered by trained assistants under the personal supervision of the medical staff which directs by prescription the kind of bath, temperature, pressure and duration. Prescriptions are carefully followed. The effects are noted by the prescribing physician and modifications made to suit the requirements and pathology of the case. The effects of the baths are tonic, eliminative and local.

The radio-activity of the waters increases the effects of the baths especially on the tissue oxidation and metabolism, which suggests their application in gout and nutritional disorders. The baths are indicated in diseases of the stomach, intestines, liver, kidneys, blood vessels, gout, rheumatism, diabetes, obesity and diseases on the nervous system and skin.

*Medical Department.*—The medical department is composed of a staff of eminent physicians of long experience and training in all the branches of medical hydrology. The benefit to be derived from a course or cure at a mineral spring depends upon the efficiency of the medical department. The medical staff here has always been and continues to be efficient and progressive.

FIG. 15.—West Baden Springs Hotel.

## West Baden Springs.

(*West Baden Springs, Ind.*)

*Location.*—Situated in a charming valley in southern Indiana, through which the mystical Lost River slowly wends its way, while the age-old hills stand in watchful guard, is the world-famous health resort, West Baden, renowned for its medicinal springs and healthful as well as delightful environment.

*Origin and Character of the Waters.*—A number of springs break forth from the Chester limestone, at the junction of that formation and the overlying Mansfield sandstone. Of these, 3 have been improved by excavating large circular basins, 6 to 10 feet in depth, about their outlets and then cementing the floor and walls of these basins.

The waters of the 3 springs contain in varying degree sodium and magnesium sulphates, sodium and magnesium chloride and bicarbonates of sodium, calcium, potassium, magnesium and the oxide of iron. The waters are also charged with hydrogen-sulphide gas, and are classed as sodic magnesic sulphated and bicarbonated saline waters, sulphuretted. The waters exert strong laxative, diuretic and antacid properties. The waters from these springs have been used for more than a century by the white man to eliminate the waste products of the body through the bowels, kidneys and skin. The waters are highly endorsed as beneficial in the treatment of diseases of the stomach, intestines, liver and kidneys.

*Bathing Department.*—The department of balneotherapy occupies the entire sixth floor of the West Baden Springs Hotel, and is modern in both construction and equipment. Every facility has been provided for the scientific application of the latest knowledge of hydrotherapy and balneotherapy, including Turkish, Roman, electric-light, the famous sulphur and hot-sulphur mud and vapor baths. All of these are given by trained masseurs and masseuses under the direct supervision of a member of the medical staff.

*Dietotherapy.*—Dietotherapy is a feature of the treatment of West Baden Springs. A special diet kitchen is maintained apart from the hotel dining-room, where special dietaries are prepared on prescription for the individual needs of the patient, under the supervision of the prescribing physician.

*Medical and Surgical Department.*—This department supervises the bathing establishments and, while an integral part of the West Baden Springs Hotel, it is a separate institution and under individual management. Here in this famous spa is a complete modern hospital, fully equipped with the latest and most approved type of apparatus, including sterilizing and operating-room. The *medical and surgical directors* are eminent members of the medical profession and of recognized ability. The whole staff consists of some 25 competent assistants, including physicians, nurses, dietitians and technicians.

Fig. 16.—Poland Spring Hotel, Maine.

## The Poland Spring Spa.

(*Maine.*)

*Location.*—The spring is situated atop an elevated plateau, 800 feet above sea level and overlooks the surrounding landscape. In the distance are the majestic peaks of the White Mountains and the Rangely Lake region, and to the south Portland harbor can be seen on a clear day.

*Meteorological Conditions.*—Fair weather predominates; the average number of cloudy days has not exceeded 85 for a long period of years. The air is much drier than would be expected from the nearness to the Atlantic Ocean. The average annual temperature in summer is 18.9° C. (66° F.), falling to a mean temperature of 5.6° C. (22° F.) for the winter.

*Accommodations.*—The meager accommodations for the first visitors to the springs a half century ago have expanded, until they now embrace one of the finest resort hotel developments, perhaps, in the world, comprising 3 modern hotels, the largest of which will accommodate 1000 guests. No expenditure has been spared which makes for comfort, pleasure and social diversion. The appointments are faultless; the service and cuisine are maintained on a basis which has established a high standard among resort hotels.

*Bathing Establishments.*—The bathing department is situated in a wing of the Mansion House, and is modern in construction and equipment. Every known form of medicinal baths, electro-therapeutic treatments and scientific massage is administered by expert attendants under the supervision of the medical director.

*Geology.*—The Poland Spring issues from a fissure near the crest of a magnificent mound of gneiss rock, scarcely distinguishable from the original granite and, as geologists tell us, it is the oldest of the sedimentatory rocks. The bed rock of this spring being of gneiss, the water is virgin in origin, coming from great depths below the earth's surface.

The Poland Spring water is a bland diuretic of low mineralization, which has proved itself to be of considerable therapeutic value in various forms of kidney trouble and hepatic and renal calculi. Its clinical use has established the fact that it is a mild efficient diuretic, and it can be advantageously prescribed whenever a depurative is indicated. While the purity of the Poland Water is unquestioned, still its purity cannot be the sole secret of its diuretic and curative properties, as would be the logical sequitur, that if purity alone was the explanation, then distilled water would achieve the same results. Clinical experience, however, has irrefutably demonstrated that this is not the case.

*Professional Endorsement.*—The archives of the Poland Spring Company contain an enormous volume of unsolicited testimony from

FIG. 17.—Section of bottling works, Poland Spring, Maine.

FIG. 18.—The famous Poland Spring.

physicians throughout the country attesting the therapeutic value of Poland water in a wide variety of pathological conditions. Its use has been found especially valuable in all forms of kidney affections and splendid results have been attained in many cases of congestion of the liver. Many eminent medical authorities have endorsed the efficacy of the water. Professor Hobart Amory Hare in his *Practical Therapeutics* recommends the use of Poland water in the treatment of scarlet fever and scarlatinal nephritis.

F. Forcheimer in his work, *The Prophylaxis and Treatment of Internal Diseases* (subject, Bright's disease, under treatment, p. 450) recommends the use of mineral waters, freely given in large quantities, and names Poland water as being especially efficacious; on page 462 (subject, pyelitis, under treatment) he recommends that large quantities of fluid should be given when it becomes necessary to flush the kidneys, advising mineral waters for this purpose, among them Poland water; on page 465 (subject, nephrolithiasis) he recommends that the patient should drink some form of mineral water for the purpose of alkalinization of the urine, but notably for the purpose of diluting it, and again mentions Poland water and recommends it.

Sir William Osler, in his *Practice of Medicine* (subject, chronic Bright's disease, p. 701), states that patients derived much benefit from an annual visit to certain mineral springs, among them Poland Springs, in the United States, and Vichy and other springs, in Europe.

An analysis of the clinical data submitted by the Poland Springs denotes that not only have remarkable benefits been derived from the administration of Poland water in the foregoing diseases, but there is abundant evidence that it has given satisfactory results in averting the albuminuria of pregnancy, in preventing the recurrence of gallstones and renal calculi after operation, as well as its usefulness in a wide variety of gastro-intestinal disturbances.

It is extremely difficult to advance a valid reason for the potent, therapeutic properties possessed by this water. As previously mentioned, its curative virtues cannot be ascribed to its chemical content, nor to its unvarying purity. When the analytical chemist cannot give an explanation, one must perforce wander into the realms of conjecture. The most probable theory propounded is that of Professor Haertl, the scientific director of the renowned springs at Bad Kissengen, when he said: "Mineral waters come from the deepest unknown depths of the earth, where they have been subjected to enormous pressure, intensive heat and forcible gas tensions, charged and surcharged with various catalytical and electrical energies employing their peculiar therapeutic values. From the depths of the magma below they bring tremendous forces to the surface which human ingenuity could never duplicate."

Fig. 19.—The Pinebrook Inn, Siloam Springs, Howell County, Mo.

## Siloam Springs.

(*Missouri.*)

*Location.*—In a natural amphitheatre, on the southern slope of the Ozark Mountains in Howell County, Mo., at an altitude of 1200 feet above sea level. The climatic conditions are favorable; the summer months cool throughout, the fall ideal and the winters never severe, the thermometer rarely registering zero.

The Siloam Springs waters belong to the calcic, magnesic, bicarbonated alkaline classification. They contain carbonic-acid gas and sulphuretted hydrogen, and possess diuretic and antacid properties. They are claimed to possess therapeutic properties similar to the celebrated Carlsbad Springs of Bohemia in Europe.

*Clinical Indication.*—The waters are highly endorsed by physicians in the treatment of a wide range of diseased conditions, including rheumatism and disorders due to an excess of uric acid in the blood and tissues; diseases of the genito-urinary tract; diseases of the gastro-intestinal tract; diseases of the liver and gall ducts; and neurasthenia.

*Professional Endorsement.*—The archives of the springs contain numerous published articles from medical literature bearing on the curative properties of the waters. In 1913 Dr. W. E. Echles, an eminent physician of southern Missouri, after a long professional experience in the practice of medicine in the vicinity of the springs, published the following: "I have witnessed many remarkable recoveries from dropsical effusions, from dyspepsia, hepatic disorders and the gouty diathesis, rheumatism and incipient Bright's disease.

Dr. P. D. Gunn, a prominent physician in southern Missouri, who has an extensive experience with the use of the water, says: "I have had ample opportunity to observe the therapeutic properties of the Siloam Springs in a case of rheumatism in my own family, whom I sent to the spring for treatment, and who was completely relieved of the disorder and who had previously visited resorts without relief."

Dr. I. A. Norman, an eminent physician of southern Missouri says: "As a practitioner who has had abundant opportunity to witness the therapeutic effects of the Siloam Spring waters," I can positively say that the medicinal properties of these waters are not equaled in this country. For dropsical conditions they are a valuable auxiliary in the treatment, often a remedy alone. Rheumatism in its various forms has been successfully treated. Chronic hepatitis and kidney disorders have been relieved; renal and vesical calculi dissolved.

*Bathing Establishment.*—In connection with the Pine Brook Hotel, there is a bath-house, modern in construction and equipment, conducted under the personal supervision of a competent physician with a corps of trained assistants.

*Accommodations.*—Two good resort hotels and 20 cottages offer modern conveniences and accommodations for guests and patients.

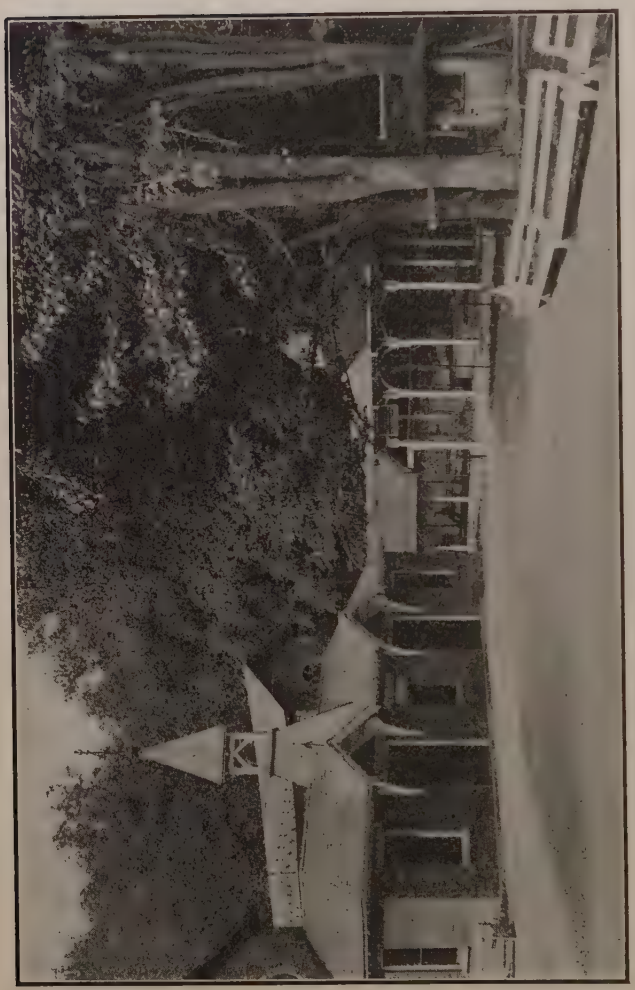


FIG. 20.—White Sulphur Springs and bath-house, Sharon Springs, N. Y.

## The Cure at White Sulphur Springs.

(*Sharon Springs, N. Y.*)

*Location.*—The area of these springs is located in the celebrated Mohawk Valley region, situated between the Adirondack and Catskill Mountains, at an elevation of 1100 feet above sea level. This area is noted for its invigorating climate and healthful surroundings.

The White Sulphur Springs water is remarkably pure, and has been endorsed by the medical profession for its potent therapeutic properties, both for "drinking" and "bathing" cures. This spring is remarkable for its large flow, exceeding 28,800 gallons daily, unaffected by drought or flood. Notwithstanding its high sulphur content, it is a delightful potable water. It is difficult for the analytical chemist to make so complete an analysis of a mineral water that one may, from the analysis alone, determine just how that particular water must be used to produce certain therapeutic results. So, while the analysis is helpful, a long clinical experience in its therapeutic application is even more essential, and those physicians act wisely who refer their patients to competent resident physicians for advice and guidance in the use of the waters for the drinking and bathing cures. It is very unwise for any individual, other than the resident physician, to give or direct advice as to the external or internal use of the water, since the treatment must be specifically adapted to the pathology underlying the patient's ailment.

*Balneotherapy.*—The sulphur tub bath is, perhaps, the most frequent form of application and, owing to the strength of the sulphur content and its affinity for metals, a specially constructed, non-absorbing, easily cleansed, sanitary tub is used. The temperature and duration of the tub bath must vary, according to the condition or disease to be treated, the individuality of the patient and his idiosyncrasies. These baths are indicated in the treatment of the different forms of rheumatism, acute, subacute and chronic; neuritis, sciatica, neuralgia, neurasthenia and other subnormal conditions and for the many intractable forms of skin disease, especially eczema. The addition to the bath of the extract of pine needles, as obtained from the Black Forest in Germany, has been found advantageous, due largely to its sedative action on the terminal nerves of the integumentary system.

*External Douche.*—The employment of the external douche has been found highly beneficial, where a deep penetrating effect is required. This necessitates both a knowledge and care in prescribing, as well as intelligence and faithfulness on the part of the attendant. This form of treatment is especially adapted for local affections, such as stiffness of joints and sprains. It is also indicated in depleted run-down conditions from overwork, either mental or physical. It has proven to

FIG. 21.—Inhalation Room.

FIG. 22.—The solarium, White Sulphur Springs, Sharon Springs, N. Y.

be one of the successful forms of treatment for sciatica and other neuralgic disorders. It has also been found useful in pelvic congestions.

*Internal Douche.*—Experience has demonstrated the fact that the sulphur water, owing to its aseptic and healing qualities, is especially indicated as a vaginal douche and for colonic irrigations. A fully-equipped department, under the supervision of the resident physician, is conducted for the administration of these treatments, with experienced assistants in attendance.

*Steam Sulphur Massage.*—Where a decisive action is essential in subacute and chronic affections of the muscles, joints, etc., full steam sulphur massage is prescribed by the attending physician. This treatment consists of a hot sulphur bath and a steaming with sulphur water over the steam table, with the scientific application of massage according to prescription. This method of treatment has also been found advantageous in obesity and helpful in restoring normal skin function.

*The Inhalatorium.*—The inhalation building is fully equipped for administering vaporized sulphur water to which has been added pine needle extract. These systematic inhalations have proved efficacious in catarrhal conditions of the respiratory system, nasal, pharyngeal, laryngeal and bronchial. The treatments are followed by the application of atomized pine-needle oil, which exerts a soothing effect.

*The Nauheim Bath.*—The Nauheim baths have been used for a number of years, with great success as an adjunct to the sulphur-water treatment, with or without the Schott resisting exercises. These baths, by lessening the frequency and strengthening the impulse of the heart beat, affords the heart needed rest, and so serves as a most helpful agent in restoring compensation. This form of bath is particularly indicated in heart cases with valvular lesions, in which compensation, having existed, has failed to show symptoms of failure of the muscular power of the heart; also in angina pectoris and in some types of cardiac neuroses. In neurasthenia, anemia and chlorosis this type of bath has been beneficial to many patients.

*Cruonotherapy.*—The "drinking cure" is as essential as the "bathing cure," and requires even more careful supervision. Both the White Sulphur and the Magnesia Springs are alkaline sulphur waters, and their internal administration is suitable in a wide range of diseased conditions. The "drinking cure" is outlined by the medical staff, and the water is taken always according to prescription.

*Medical Department.*—The medical department is supervised by a eminent physician, well versed in medical hydrology. The bathing establishment is a model in construction and equipment, and prepared to administer the latest knowledge in balneotherapy. All cures are directed on prescription and administered by trained assistants, whose work is regularly checked up by the medical staff.

Fig. 23.—Aërial view of part of the State Reservation at Saratoga Springs, showing Washington and Lincoln Bath-houses.

## The Saratoga Spa.

### (*Saratoga Springs, N. Y.*)

The New York State Reservation at Saratoga Springs is owned and and operated by the State under the jurisdiction of the Conservation Commission. Included in this reservation are three parks of several hundred acres in area, in which are to be found all of the important natural mineral water springs of this widely known resort, 3 modern bath-houses for the administration of all forms of hydrotherapy, a public drink hall and 2 bottling plants.

Chemically and therapeutically the waters are similar to those of Bad Kissingen, and are classified as muriated alkaline saline carbon-dioxated. Internally, these waters are beneficial for treatment of rheumatism, gout, neuritis, dyspepsia, constipation, acidosis and various liver and stomach disorders.

*Bathing Department.*—Externally, the waters are used for the treatment of arthritis, neuritis, diseases of the heart and circulatory system. The baths are administered in courses with practically the same regimen as is carried on at all of the well-known foreign spas. The bathing waters are more abundant and more highly saturated with carbon-dioxide gas than any of the European waters.

*Gaseous Content.*—Each volume of water contains from 3 to 4 volumes of free carbon dioxide, which is so thoroughly held in solution by the water that the patient feels no inconvenience from the inhalation of the gas during the period of the bath. In carrying out the Saratoga system of baths for cardiac cases the quantity of gas in the water is reduced to a minimum for the first few baths, gradually increasing in amount as the series progresses, until finally full saturation is reached for the final baths of the course.

The treatments have been so successful that in the short period of ten years the number has increased from about 10,000 to over 90,000 annually. Treatments given in one day during the height of the season number as high as 2200.

The consensus of opinion among scientific physicians regarding the efficacy of modern mineral hydriatry has made it comparatively easy for the State Conservation Commission to establish a *rapprochment* with the profession. The future popularity of Saratoga Springs with the American people is assured by reason of the *entente cordial.*

The state of New York, through its legislature, has appreciated the possibilities of Saratoga Springs as a leading health resort and has, through appropriations, kept pace with the ever-increasing demand. There is every reason to believe that this progressive policy will be continued, and to such an extent that there will be supplied a large combined hotel and sanitarium, a new bath-house, golf links, tennis courts and all the accessories necessary to elevate Saratoga Springs to the position of the world's leading health resort.

FIG. 24.—New Panacea Springs Hotel, Littleton, N. C.

## Panacea Mineral Springs and Hotel.

(*Littleton, N. C.*)

*Location.*—Three miles from Littleton on the ridgeway of central North Carolina, in a natural amphitheatre surrounded by giant boulders of granite and gneiss, which have stood guard in silent majesty for centuries.

*Climate.*—The altitude of the springs is something more than 500 feet above sea level and 300 feet higher than places only 25 miles to the east. This delightful region has a balmy, yet invigorating climate, much like that of the world-famed south of France, with the added attraction of towering majestic trees of the primeval forest, in which the North Carolina pine predominates. The ozone from the pine needles gives a tang to the air, which is refreshing and invigorating to the tired and weary.

The *mineral waters* at Panacea Springs were known to the red man as a "lick" for centuries before the coming of the Europeans. There is yet remaining, mute, but unquestioned, evidence of the value placed upon the waters by the aborigines of eastern North Carolina. The waters of this spring burst forth from a crevice in a prehistoric stone—a giant granite boulder. Here the Indians hollowed out of the solid rock from which the water flows round basins, the size of a man's hat (characteristic of his race), which was found when the white men discovered the spring. This spring, according to legion, was the "Medicine Spring" of the red man, who believed around it hovered the "Great Spirit of Healing." For chemical analysis, therapeutic properties and clinical indications of these waters, see Chapter XIV, p. 537.

*Medical Properties.*—The therapeutic virtue of this water is due to the mineralization. The iron and maganese bicarbonate exert tonic, alterative and reconstructive properties. The percentage of hemoglobin of the blood stream is increased and the powers of assimilation augmented without overtaxing the digestive function. The water is heavily charged with natural carbonic-acid gas which imparts valuable therapeutic qualities to the water.

*Professional Endorsement.*—These waters are highly endorsed and freely prescribed by physicians in a wide range of diseased conditions, including gastric affections due to acidity and hyperacidity and in all irritable conditions of the kidneys and bladder, chronic skin diseases, rheumatism and as a tonic in debilitated conditions of ill health. The bicarbonates of iron and manganese impart to the water valuable tonic alterative and reconstructive properties in anemic states and where the coloring matter of the blood is below normal. Physicians from all over, both Carolinas, Virginia, Georgia, Alabama and Mississippi, send patients to Panacea, not only for the medicinal benefits of the water, but on account of the happy medium in altitude for those accustomed to warmer climates and lower altitudes.

FIG. 25.—The new Bedford Springs Hotel and bathing establishment.

Below—The old Bedford Spring Hotel, Bedford Springs, Pa.

## Bedford Springs.

(*Pennsylvania.*)

The Bedford Springs are tucked away among the foothills of the Alleghanies, at an elevation of 1300 feet above sea level, surrounded by a veritable paradise of primeval forests and a country side rich in historical memoirs. The climatic conditions are ideal, delightful and invigorating. The bracing air of the mountains is tempered by a climate that holds the softness of springtime throughout the summer, with bright days and cool, restful nights.

*Accommodations.*—The hotel is a charming combination of the old and the modern. The original hostelry, dating back more than a century, has been supplemented by a five-story, fireproof building which, when fully completed, will contain 400 bedrooms and baths, with every convenience contributing to creature comfort. The appointments throughout are most modern and luxurious.

*Waters.*—The purity of these waters is guaranteed by the preservation of the entire watershed as a natural park in almost its native wooded grandeur. No dwelling is permitted on the mountain from the base of which the springs flow, and beautiful paths and summer houses are the only changes wrought since the springs were first discovered in 1804.

*Cure.*—There are numerous springs on the Bedford Estate, with a variety of mineralization. The Magnesia Spring, particularly, being slightly hypotonic to the blood, and related at least in its saline properties, supplies an agent which by its easy absorption and free elimination from the body facilitates the removal of waste products and makes it a valuable adjuvant in the treatment of all metabolic disorders. Its therapeutic properties as a general cleanser makes it of value in maintaining an already healthy condition. This water is laxative in small doses and purgative in larger dosage. The small lithic chloride content widens its field of usefulness especially in disorders of the bladder and kidneys. The cure is especially applicable for the treatment of gout, gall-stones and liver, kidney and stomach disorders. The "Bedford Cure" is a rational, scientific course of treatment of three weeks' duration, consisting of the prescribed drinking of the mineral waters combined with carefully regulated dietetic supervision, exercise, baths and scientific massage.

*Bathing Establishment.*—The bathing establishment is modern in construction and equipment, offering every advantage abreast with the latest knowledge of hydrotherapy and balneotherapy. Expert masseurs and masseuses, under the direction of an expert in hydrology, gives the baths and massage treatments.

*Professional Supervision.*—An eminent physician skilled in hydrological science, resident in the hotel, is in constant attendance to advise concerning the "Bedford Cure" and to direct its administration.

FIG. 26.—The Braun Bath-house and Hotel, Braun Hot Springs, South Dakota.

## The Braun Bath-house and Hotel.

(*Hot Springs, South Dakota.*)

*Location.*—These springs are in the celebrated Black Hills of South Dakota, on the banks of Fall River, in the beautiful valley of the Minnekahta, sheltered with a wall of rugged mountains, which encircle the area like the protecting arm of some mighty giant.

*Climatic Conditions.*—The statistics of the United States Weather Bureau show that the temperature from June, July and August, covering a period of eight years, averaged 16.7° C. (62° F.); in December, January and February, for the same period, the temperature averaged 2.2° C. (28° F.). The altitude is 3400 feet above sea level. The atmosphere is dry, pure and invigorating. The crisp mountain air and the ozone of the pines are invigorating.

*Professional Endorsement.*—From observation and information we recommend Hot Springs as one of the best resorts for those suffering from rheumatism, gout, malaria, chronic diseases of the liver, kidneys and bladder, chronic bronchitis, incipient consumption, indigestion, neurasthenia, neuralgia and all chronic skin diseases" (George H. Jenkins, M.D., Keokuk, Iowa; M. N. McNaughton, M.D., Villisca, Ill.

*Bathing Establishment.*—The methods of treatment accord with all the latest knowledge in hydrotherapy, balneotherapy, electrotherapy, mechanotherapy, in their various branches, including vapor, shower and sitz baths, electric-light and solar-light baths, also Nauheim baths, etc. Massage and Swedish movements are used in selected cases. In addition to hydrotherapy and balneotherapy, the bathing establishment is equipped for the scientific application of all electrical modalities, including high-frequency, diathermy and sinusoidal currents and vibrations, as well as powerful mechanical vibration for stimulating nerve roots of the spine and increasing the circulation. High potential high frequency for the reduction of high blood-pressure, etc. A medical director of long experience with trained assistants supervises this department.

*Massage Movements.*—These are scientifically applied in selected cases, and are particularly beneficial in feeble and nervous patients whose lack of vitality or various physical afflictions prevent their participating in usual out-door physical exercises. *Swedish movements* combined with massage increase the lymphatic flow, improves muscular action, strengthens nervous tone and stimulates the circulation.

A noteworthy feature of the institution is that the bathing establishment and the hotel are under the same roof, thus making the care of patients and their scientific treatment convenient, without undue exposure to climatic conditions. The hotel department offers every modern convenience for the comfort of the patient. The location, in the southern end of the celebrated, picturesque, pine-covered Black Hills of South Dakota is a favored spot.

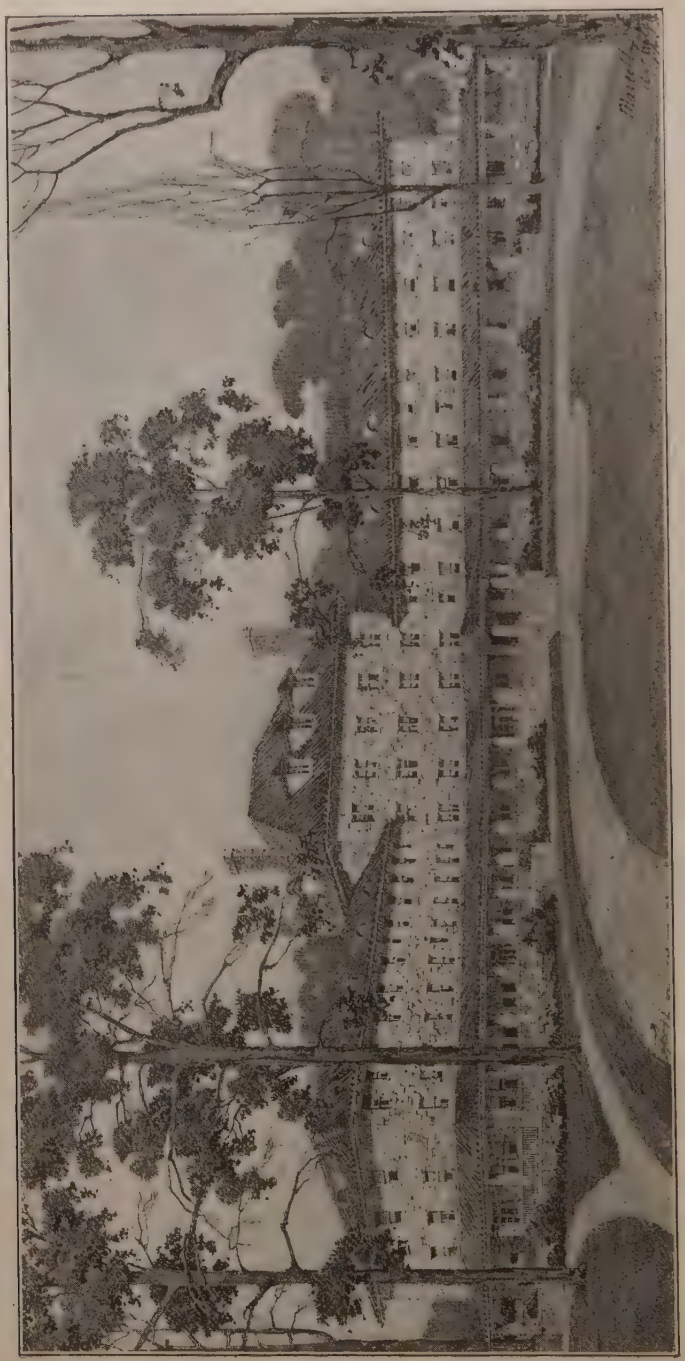


FIG. 27.—The (proposed) new Buffalo Chateau, Buffalo Lithia Springs, Va.

## Buffalo Mineral Springs and Hotel.

*(Mecklenburg County, Va.)*

*History.*—In 1728 Col. William Byrd, one of the commissioners appointed by the Crown to run the dividing line between the colonies of Virginia and North Carolina, learned from his Indian guide of a "medicine spring," to which the sick Indians went to drink the water to regain their health. The Indian took Col. Byrd to this spring, where herds of buffalo were found frequenting a "lick" on a creek just below this "medicine spring." Col. Byrd, in his report to the Crown, names this spring Buffalo Spring and the creek Buffalo Creek. From this incident the Buffalo Mineral Springs first received their name in the tongue of the white man.

*Location.*—Located in the beautiful Buffalo Hills, the springs comprise an area of about 8 square miles in Mecklenburg County, in the southeastern tidewater section of Virginia; north of the North Carolina boundary line, 3 miles. The altitude is about 550 feet above sea level, with an elevation slightly higher than the surrounding country.

*Climatic Conditions.*—Dr. W. A. Plecker (*Med. Rec.*, August 27, 1904), discussing the climate of tidewater Virginia, says: "This is the garden spot of the western hemisphere, most nearly meeting all the requirements of a perfect climate. The average temperature for the twelve months is 14.8° C. (59° F.). The winter temperatures are moderate, rarely reaching the freezing-point for more than a few days at a time. The summer temperature is 24.8° C. (77.4° F.), which is lower than places farther north. The humidity of this section is far less than at any point along other sections of the Atlantic Coast, the relative humidity being for spring, 68.7°; summer, 71.8°; winter, 72.6°. The climate is salubrious, delightful and invigorating.

*The Buffalo Mineral Waters.*—There are 8 springs here, containing eight different types of mineral waters which have been used medicinally for more than one hundred years. The Buffalo Mineral waters, virgin in origin, are remarkably pure, coming from great depths below the earth's surface; they bubble forth through a stratum of pervious granite rock, sparkling pure as crystal from the bosom of Mother Nature. The various waters possess antacid, diuretic, antilithic, aperient and tonic properties.

*Radio-activity.*—The Buffalo Mineral waters are radio-active to a marked degree, which imparts therapeutic properties similar to that of radium. Waters containing this gas, when drunk, the gas passes directly through the walls of the stomach and intestines, passing thence by diffusion into the capillaries of the lymph and portal circulations. Waters charged with radio-active emanations energize or activate the body ferments or enzymes, stimulate to greater efficiency the proteolytic and diastatic ferments and increase autolytic, diastatic, glycolytic, urolytic, pancreatic, peptic and lactic acid fermentation.

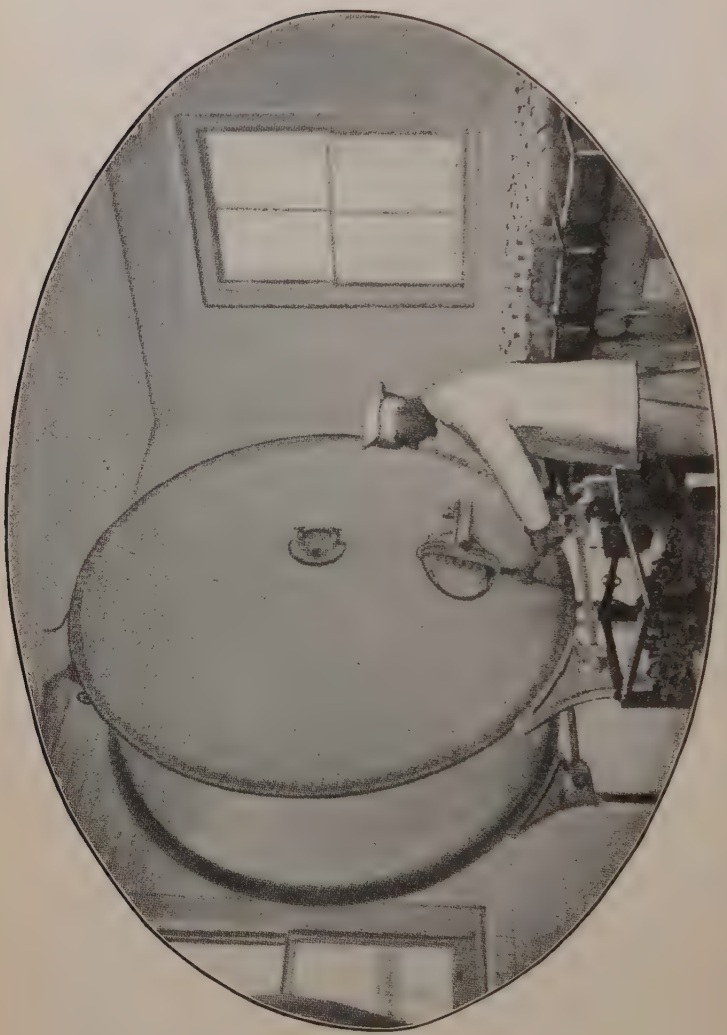


FIG. 28.—Buffalo mineral water; from one of the glass-lined, steel tanks to sterilized bottles; bottling plant, Buffalo Lithia Springs, Va.

*Recommended in the Following Diseases.* Gastric indigestion due to acidity and hyperacidity; intestinal catarrh and retarded bowel action; disorders of the renal and vesical apparatus; renal, vesical and hepatic calculi are disintegrated by their solvent action. Neurasthenia and irritable nervous conditions; anemia, chlorosis and in debilitated, run-down conditions where an iron tonic is needed; rheumatism, gout and the uric-acid diathesis; disorders of menstruation and changes due to climacteric, the albuminuria of pregnancy and Bright's disease.

*Professional Endorsement.*—The most eminent men in this country and abroad have given their unquestionable endorsement of the therapeutic value and curative properties of the Buffalo Mineral waters: Authors of works on the practice of medicine and materia medica; editors of medical journals; presidents of the American Medical Association; professors in the leading medical schools; surgeons in the U. S. Army and Navy; physicians and surgeons on the staffs of the leading hospitals of the country.

*Hotel.*—For more than a century this "old-fashioned" Virginia resort has entertained the "first families" of the South as health-seeking guests. The old cottage-plan hotel, still comfortably housing 250 guests, is soon to be replaced with a magnificent hostelry. The new Buffalo Chateau, an imposing structure of pleasing architectural design, of granite steel and concrete construction, will accommodate 500 guests.

*Bathing Establishment.*—The bathing establishment will be of the same construction as the Chateau. The equipment will comprise every known physiotherapeutic appliance for the scientific application of the latest knowledge of hydriatics to be found at any spa in the world. Every known bath, douche, pack, rub and fomentation will be administered by trained assistants under the personal supervision of an eminent authority on hydrology.

*Medical Department.*—The medical department is administered by an eminent physician who is one of the most able authorities on medical hydrology in this country; the bathing establishment and general sanitation of the bottling plant is under his personal supervision.

*Bottling Plant.*—The springs are protected from surface drainage and every possible source of contamination. The waters are pumped from the springs to glass-lined, steel storage tanks in the bottling plant. The equipment of this plant comprises every known appliance approved by modern science for the complete and perfect sterilization of bottles and corks and for the perfect sanitary handling of a medicinal water.

A resident bacteriologist carefully examines two specimens of water from each tank prior to bottling, and no sample has ever been examined which did not show by actual test that its purity excells the requirements laid down by the United States Bureau of Chemistry, Department of Agriculture (food and drugs). (See also Chapter XIV.)

Fig. 29.—Virginia Hot Springs.

## The Cure at Virginia Hot Springs.

(*The Homestead.*)

*A Foremost Spa Resort.*—The cure at Virginia Hot Springs is one of the foremost in America. The basis of the cure is the radio-active water.

*Highest Radio-active Springs in America.*—A recent survey of all the known radio-active springs everywhere brought to light these interesting facts. It was found that the springs at Hot Springs, Va., had the highest degree of radio-activity in America, and, moreover were considerably higher than those at the celebrated European spas.

| Radium emanation in Mache unit per liter. | Mache units in bath of 200 liters. | Location. |
|---|---|---|
| 285 | 57,000 | Hot Springs, Va. |
| 265 | 53,000 | Hot Springs, Ark. |
| 125 | 25,200 | Baden-Baden, Germany. |
| 91 | 18,200 | Bath, England. |
| 68 | 13,600 | Watkins Glen, N. Y. |
| 55 | 11,000 | Carlsbad, Czecho-Slovakia. |
| 31 | 6,200 | Aix, Les-Baine, France |
| 29 | 5,800 | Nauheim, Germany. |

As Mme. Curie has said: "The higher the emanation capacity of a given spring, the more striking are the physiological results."

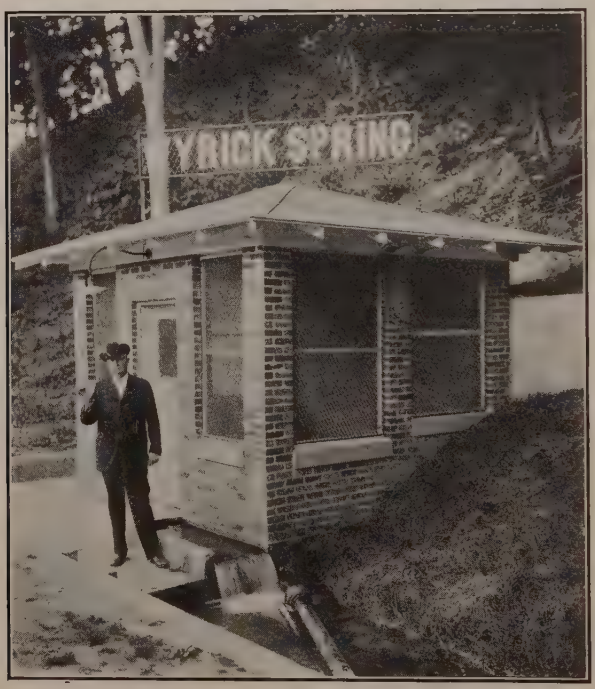
*Types of Baths.*—The baths are the most important features of the cure. There are many varieties: Tub baths in flowing water, where some 7 or 8 hundred gallons are used per bath; spout baths, in which the water is delivered under a pressure of 12 to 16 pounds; milder tonic baths, with needle douches.

*Supplementary Treatments.*—To increase the effectiveness of these baths, patients are given hot packs, massages, superheated air treatment with Tyraur apparatus, local exercising with Zander machines. A routine of exercise, rest and diet is prescribed for them, based on the advice of their own doctors and the reactions to the cure.

*Bathing Establishment.*—The department of balneotherapy is most modern in construction and scientific in equipment, embracing every phase of balneotherapy and physiotherapeutics, including the Richter bath, circular, rain and Scotch douche, hot-air and electric-light cabinets and a complete Zander institution. All treatments are given on prescription and diligently supervised by some member of the medical staff. The coöperation of the family physician is helpful and welcomed.

*Medical Supervision.*—The medical staff is composed of eminent members of the medical profession, experts in the science of medical hydrology. The equipment of the medical department includes every known physiotherapeutic apparatus and method used at any spa in the world.

Wyrick Inn, Crockett, Va.




Wyrick Springs.
Fig. 30.

## Wyrick Mineral Springs and Hotel.

(*Crockett P. O., Va.*)

The *hotel* is a modern resort hostelry fully equipped with all up-to-date appliances, offering every modern convenience for the comfort of guests. The situation is at the base of a mighty cliff, amid picturesque surroundings, on the crest of the Blue Ridge Divide, near the highest point of the Alleghany Mountains, in southwest Virginia, at an elevation of 2387 feet above sea level. The hotel is supplied exclusively with the famous Wyrick Spring water, and here "midst the lofty mountains in all their splendid grandeur" the tired mind and the worn-out body are reinvigorated.

The *bathing establishment*, modern in construction and equipment, offers every facility for administering hot and cold mineral water baths (free to guests), so that they may receive the full benefit of the Wyrick Spring waters. The bathing and "drinking cure" combined clears up the skin and complexion, stimulates metabolism and promotes normal activity of the organs of digestion and elimination.

The Wyrick "*drinking cure*" has proven highly beneficial for the relief of many diseased conditions, especially when due to absorbed toxins, giving rise to distressing, debilitating symptoms and often leading to serious ailments when left without proper treatment. Indigestion, dyspepsia, gastritis, rheumatism, eczema, bladder and kidney affections, incipient Bright's disease and diabetes, the uric-acid diathesis, renal, vesical and hepatic calculi. The highest authorities are now attributing miraculous restorations to health to the possibility of the spring being highly radio-active, along with the free natural carbon dioxide, that gas possessing powerful solvent and eliminant properties.

*Professional Endorsement.*—These waters are highly endorsed and freely prescribed by the medical profession in a wide range of diseased conditions. Charles Fox Graham, M.D., says: "It is of great benefit as an aid in the treatment of all types of kidney and bladder trouble, and its bland soft qualities make it a water borne easily by the most delicate stomach. It proves successful in many cases in combating and ameliorating the disagreeable symptoms accompanying early pregnancy, such as the nausea and vomiting, and it is also of value as a prophylactic against the more severe kidney insolvents which may arise during the latter stages of pregnancy." A. G. Crockett, M.D., says: "It gives me great pleasure to state that I regard Wyrick mineral water as one of the best mineral waters of which I have any knowledge. It will be found curative in a great variety of skin eruptions, such as chronic eczema, psoriasis, etc.; in glandular troubles, scrofula, rheumatism, etc. From observing its effects closely, I regard it invaluable in cystitis, Bright's disease and, in fact, all troubles of the bladder and kidneys. (See Chapter XIV.)

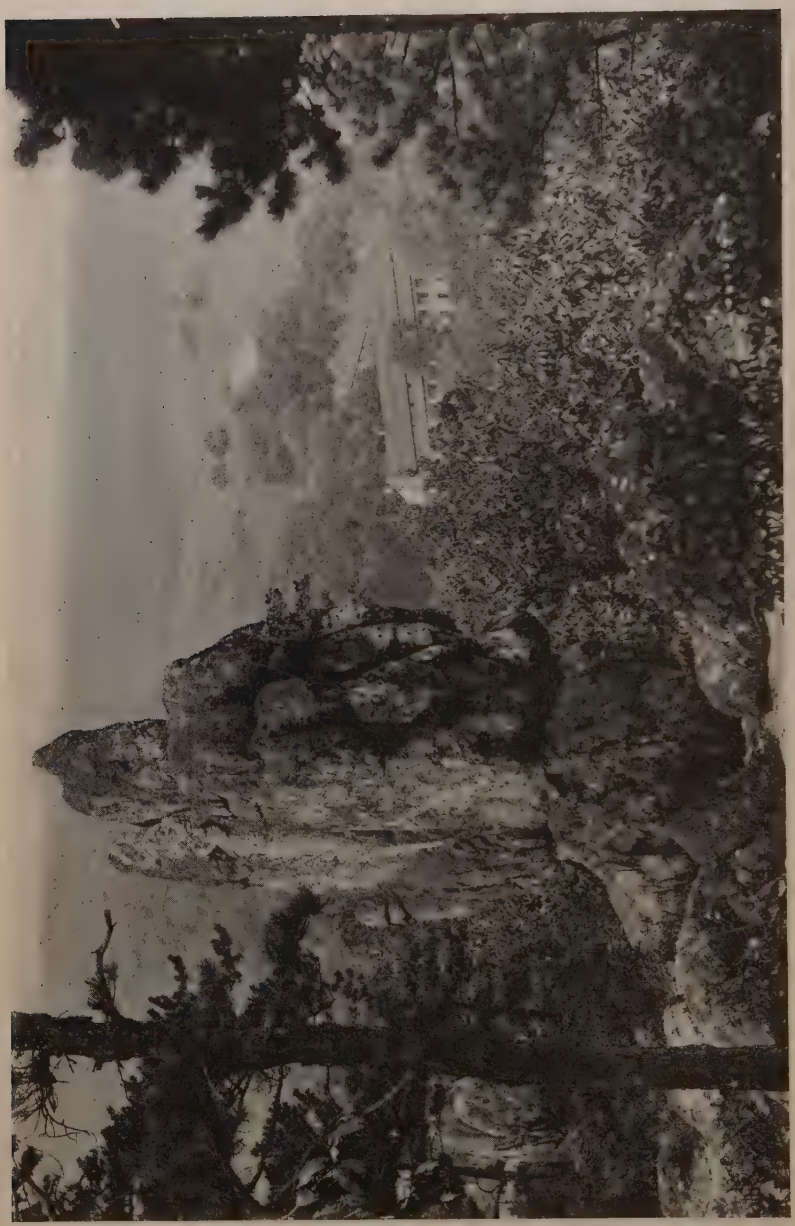


FIG. 31.—White Cliff, overlooking Capon Springs.

## Capon Springs.

*(West Virginia.)*

For more than two centuries Capon Springs have enjoyed a constantly increasing reputation for cures so remarkable in many cases as to be deemed almost miraculous. A log cabin now standing there was built in 1761 and others were built long before that, while before any houses were built planters camped out there to drink Capon water which the Catawba Indians called Cacapaon, "healing water." Brief extracts from great leaders in the medical profession are given herewith. Such standard medical works as Dr. Frank P. Foster's *Practical Therapeutics*, Dr. Roberts Bartholow's *Materia Medica and Therapeutics*, Dr. George E. Walton's *Mineral Springs of the United States and Canada* and Dr. A. H. Buck's *Reference Handbook of Medical Science* endorse the Capon Springs water. Articles J. M. Da Costa, J. L. Le Conte and others in the *American Journal of the Medical Sciences*, by Dr. T. A. Ashby in the *Maryland Medical Journal* and by Dr. J. L. Ludlow in the *American Journal of Obstetrics* attest the value of Capon water as a medicinal agent.

Capon Springs water was shipped to France in 1924 for the use of the American Olympic Team and the head coach, Mr. Lawson Robertson, wrote in 1925 that these American athletes, "using this water exclusively in training were in the finest physical condition it has ever been my privilege to see a group of men."

Dr. James K. Barnes, former Surgeon-General, United States Army, wrote: "For kidney troubles especially Capon Springs is the best in America."

Dr. Wm. P. McGuire, former President of the Medical Society of Virginia and President of Farmers' and Merchants' National Bank, Winchester, Va. (after fifty years' use), wrote: "For uric-acid troubles and diseases, such as gout, rheumatism, kidney troubles, calculus, I think it is invaluable."

Dr. Joseph M. Mathews, formerly President of the American Medical Association and of the State Board of Health of Kentucky, wrote: "I have examined, prescribed and taken many lithia waters, but I have found none so good as Capon. In all cases of excessive uric acid, affections of the stomach, irritation and inflammation of the genito-urinary organs and kidney troubles these waters are to be prescribed. I have always heretofore held to the view that it was the 'much taking' of any mineral water that did the 'good,' but during my stay at Capon I was persuaded that this was not so, at least of the Capon lithia water. A few glasses daily seemed to meet the case better than much drinking. Whereas, I took only a moderate quantity of the water, 3 or 4 glasses daily, and received much benefit, many that I noticed took it in large quantities with seeming benefit, certainly with no discomfort. That the water has a marked action

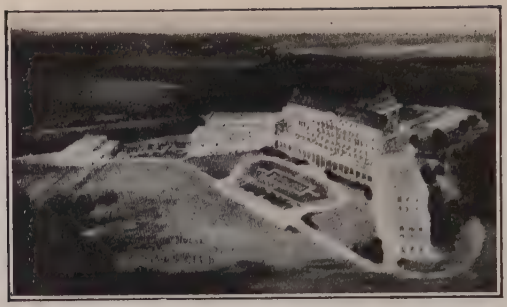


FIG. 32.—Proposed new club-house of Capon Springs Club.

FIG. 33.—Bathing pavilion at Capon Springs, W. Va.

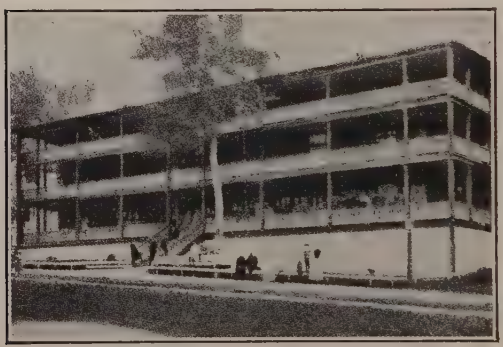
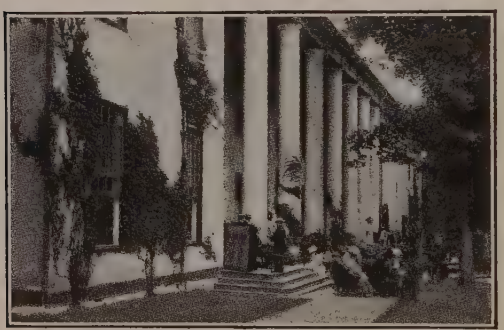


FIG. 34.—Present club-house, Capon Springs, W. Va.



FIG, 35.—Mountain House, Capon Springs, W. Va. Built in 1850,

upon the secretions and, secondarily, upon the blood cannot be disputed."

Dr. Bedford Brown, formerly President of the Southern Surgical and Gynecological Association and formerly President of the Medical Society of Virginia, etc., wrote: "Having been familiar with it for forty years, I regard Capon Spring water as one of the most valuable in America. It is especially valuable in uric-acid diathesis and all that long list of diseases arising from that cause, as gouty and rheumatic tendencies, affections of an organic and functional nature of the kidneys, as Bright's disease, renal dropsy, ordinary subacute nephritis, catarrh of the bladder, inflammation of the prostate gland and affections of the urethra. It is equally applicable in acid and atonic forms of dyspepsia, indigestion, torpidity of the liver, functional derangement of the intestinal canal and to all affections of the skin."

Dr. Alfred Whelen, of Philadelphia, says: "The Capon Springs water is tonic, diuretic, alterative and aperient. I have known of no case of renal calculi or gravel which has not been cured by an intelligent and sufficiently long use of this water. Gout and rheumatism and their dependent conditions are always benefited or cured. Liver and stomach ailments are much benefited, and I have seen supposed incurable liver disease entirely and permanently cured. In catarrhal affections of the uterus, lungs, bladder and intestines the effects are always beneficial and often wonderful."

Roberts Bartholow, M.D., M.A., LL.D., formerly Professor of Materia Medica and Therapeutics in the Jefferson Medical College of Phildelphia, in his *Materia Medica and Therapeutics*, wrote: "Unquestionably good results have been wrought by these waters."

Dr. Thomas A. Ashby, former Professor of Gynecology, University of Maryland, wrote in the *Maryland Medical Journal:* "Capon is similar in its effects, though quicker and more positive in its action, than Vichy of France or Carlsbad of Germany."

Dr. J. L. Ludlow, former Vice-President, Philadelphia Obstetrical Society, wrote: "I have been surprised at Capon Springs at the number of ladies who came, suffering from uterine disorders. They would come feeble and unable to walk, but would improve gradually in health and finally go home well."

Dr. J. L. Le Conte, in an article in the *American Journal of the Medical Sciences*, wrote of Capon water: "In the imperfect menstruation of young girls and in chlorosis, the menstrual function has been regularly established. In these instances the effect has been probably due to the improvement of digestion and the consequent assimilation of the normal amount of iron from the food."

Dr. Hunter McGuire, former President of the American Medical Association, wrote: "Very valuable, both as tonic and alterative."

FIG. 36.—Pence Springs Hotel, Pence Springs, W. Va.

## Pence Springs and Hotel.

*(West Virginia.)*

*Location.*—The springs are located on the main line of the Chesapeake & Ohio Railway, midway between Cincinnati, O., and Washington, D. C., in the picturesque valley of the beautiful Greenbrier River, which rises high up in the Alleghany Mountains. From the hotel terrace, 1725 feet above sea level, scenic views of marvelous beauty stretch out before one's vision—towering mountains, beautiful valleys, dells and dales—bringing a sense of restfulness and remoteness from the busy work-a-day world.

*Spring No. 1 Water.*—This is sulpho-alkaline and valuable in the treatment of irregularities depending upon lack of digestion and assimilation. The bicarbonates of sodium, magnesium, calcium, strontium, lithium and iron make an admirable alkaline diuretic water. These elements are blended with carbonic, sulphuric and phosphoric acids, producing stomachic, tonic and nerve restoratives of pleasing action on diseased conditions.

*Spring No. 2 Water.*—This is a magnesium water, heavily charged with natural carbonic-acid gas. The bicarbonates of magnesium, calcium and sodium, together with the sulphates of potassium and sodium, combine to produce an admirable alkaline diuretic water of potent therapeutic properties useful in the treatment of a wide range of disorders where such a water is indicated.

*The Medicinal Properties.*—These will be readily understood by referring to Chapter XIV for analyses, therapeutic properties and clinical indications. These waters are pleasing, palatable and may be taken in quantities that in many other waters would be excessive and unpleasant. They are beneficial in conditions depending upon improper digestion and assimilation, and have been found beneficial in the treatment of atonic dyspepsia, irritable bladder and deficient kidney function, insomnia, neurasthenia and debility.

*Professional Endrosement.*—Dr. E. W. Row, Ex-President of the Medical Society of Virginia, says: "The waters are of the sulpho-alkaline variety so well blended with carbonic, sulphuric and phosphoric acids, and with the stomachic, tonic and nervous restoratives with its decided selective activity upon the kidneys, skin and liver), that I can confidently recommend these waters to anyone suffering from any form of atonic dyspepsia, deficient kidney secretion, irritable bladder, chronic bronchial asthma, insomnia or debility from any cause, especially the debility of mind and body resulting from anxiety over overwork."

*Medical Supervision.*—The "water cure" at Pence Springs is directed by a competent physician well versed in crounotherapy and balneotherapy. This department is located in the Pence Springs Hotel, and is modern in construction and equipment.

FIG. 37.—The medical department and bathing establishment, White Sulphur Springs, W. Va.

## White Sulphur Springs.

(*West Virginia.*)

White Sulphur Springs is unique as a health-giving resort since 1778, in so much as it offers every facility for modern sanitarium treatment without being a sanitarium. The location and climatic advantages make it an ideal place for the individual who desires to spend a vacation of constructive recreation.

The *waters* are all radio-active, which is not a common property of all mineral waters. The Radio-chalybeate Spring is superior in this respect to many of the best-known European springs.

The water from the old White Sulphur Springs has been used and prescribed by physicians since 1778.

In addition to this spring, there is a Chalybeate spring containing iron in an easily assimilable form.

The Alum Spring is actively astringent.

The Alvon Spring Water is brought 14 miles from the mountains in steel pipes, and is a magnificent water of very low mineral content.

White Sulphur Springs water is the natural sulphur water in a concentrated form and is generally used as a laxative and eliminant.

*The bathing establishment* has the most luxurious appointments of any similar institution in this country. The hydrotherapeutic equipment is the best offered in America. The personnel consists of a staff of expert masseurs, bath attendants and a mechano-therapeutist. All types of baths are given according to their individual indications.

Various appliances for the administration of heat are employed as electric cabinets, hot-air and steam rooms, local and general bakes, hot blanket and electric blanket packs and local and sulphur mud packs. Several types of douches and sprays are also employed. Massage is used when indicated. Special treatments, as colonic irrigations, are given by trained nurses.

All approved forms of electrotherapy are employed, as the mercury-quartz light, high frequency and diathermy. Twenty-eight types of Zander apparatus have been installed to exercise actively and passively every muscle group in the body.

*Diseases Treated.*—That large group of cases in which improved elimination is desired is chiefly benefited, as intestinal toxemia, constipation, gout, chronic rheumatoid conditions, early kidney disorders and high blood-pressure. Heart diseases, as irritable hearts, and those in the early stages of decompensation are benefited by a course of supervised routine, including Nauheim baths, and graduated exercises, starting with the simplest resistance exercises.

*The medical department* has complete charge of the health and sanitation of the resort. This department is under the charge of the resident physicians assisted by a chemist, roentgen-ray and laboratory technician and trained nurses.

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